Innovations in Sustainable Airport Planning Efforts:

A Case Study for Hartsfield-Jackson International Airport

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Introduction

Sustainability has been a growing trend in airport development. This trend has been the result of building code changes, air quality and climate regulation changes, and increasing energy costs. However, the concepts behind sustainable airport development are evolving to include a regional focus on the airport area. Key features that are commonly implemented in terminal design include increased natural light, energy-saving bulbs, recycling programs, green materials and more efficient utility systems. Although these energy efficient features are important, the latest sustainability trends look towards a more holistic approach. Additionally, more innovative "green" design components are increasingly seen in airport facilities and development as airports strive to achieve LEED certification. In addition to environmental concerns, airports are additionally starting to consider the social and economic implications and opportunities that especially impact the surrounding communities.

The vision for this research is for Atlanta to perhaps not only be known as having the "world's busiest airport," but also to have one of the world's most sustainable airports in terms of airport area development. With the emergence of the aerotropolis concept, airports are becoming iconic features of the urban landscape and planning efforts can ensure successful and sustainable development. There are many challenges to proposing such a goal – particularly that Atlanta is not known as a green community. In contrast, Atlanta is known for its pollution, traffic, and poor air quality. The report will provide insight into the negative environmental effects of energy-intensive airport operations. Additionally, the areas surrounding the Atlanta Airport are not developed to reach their highest and best use potential. It is important to consider the global context of the aviation industry, for sustainable airport design is growing rapidly at particularly the international scale.

As mentioned above, it is important to note that environmental concerns are not the only focus features of sustainable airport development. According to the Federal Aviation Administration, sustainable airports:

- Reduce environmental impacts
- Help maintain high, stable levels of economic growth
- Help achieve "social progress," a broad set of actions that ensure organizational goals are achieved in a way that's consistent with the needs and values of the local community

Figure 1: Drivers of sustainable airport development (According to FAA)

Source: Federal Aviation Administration

The FAA's definition of sustainable airports provides a framework onto which this report is built. The social, economic, and environmental categories of sustainability provide criteria that will allow the case studies and existing conditions at the Atlanta Airport to be reviewed.

With a local economic impact of $3.2 billion and a regional economic impact of $19.8 billion for 2012, the role Atlanta's airport plays in the region's vitality is quite important. Sustainable planning practices promote a healthy economy and positively impact the surrounding community. Future sustainable planning practices at Atlanta's airport can contribute to building a better airport area for businesses and community members alike.

Part of this research will consist of case study comparisons. Using ideas based on what other airports have done, the impacts will be assessed to consider their relevancy for Atlanta's Hartsfield-Jackson International Airport, or HJIA. Chicago's O'Hare Airport, Boston's Logan Airport, Zurich Airport, Amsterdam's Schiphol Airport, and Singapore's Changi Airport will all be analyzed through case study comparison to extract applicable lessons for Atlanta's airport.

One of the main initiatives of this paper is to pinpoint innovations in airport sustainability and to figure out the best implementation strategies of these ideas in application to the Atlanta Airport context. Innovation is defined as: "the introduction of something new; a new idea, method, or device" (Merriam-Webster). To remain competitive, an airport must be at the forefront of creating a facility that is attractive to passengers and utilizes the newest forms of technological development. From a business perspective, Forbes magazine agrees with these trends and states: "airports most adopt new approaches in order to actively support [the] growth of air travel, be competitive and in the long term, be successful. Future airport sustainability will be driven by innovation and creativity" (Cook, 2011). In today's fast-paced, competitive, and technology driven environment, the need to develop new and exciting ideas is more important than ever.

This report explores the best airport facility design strategies that address environmental concerns of the future. Instead of focusing on facility expansion, airport facilities should learn to adapt - whether through progressive facility design standards or adding additional green space to the surrounding community. Specifically, the research focuses on the most sustainable practices in airport master planning that are oriented towards pleasing businesses, passengers, and the community. Airport area development has been considered till now only a "minor strand of urban transportation planning;" however, the subject is "slowly gaining prominence in the planning, urban geography, and economic development literature" and should therefore be increasingly researched (Freestone and Baker, 2011, p. 263). Thoroughly researched practices will enable development guidelines to direct practices that ensure successful development.

Airport Planning and Sustainability: Concerns and Context

Before beginning the discussion of sustainable airport practices, it is important to gain an understanding of airport planning related topics and concerns. For purposes of this research, areas of interest are the carbon footprint of airports and their implications on air quality, current efforts and trends in airport planning, and the global context of the aviation industry. In addition, this section will introduce the topic of sustainability and how it relates to an airport context.

Atlanta Context: Airport and Air Quality

Based on regulations set forth by the Clean Air Act, the Atlanta region does not meet federal standards for ozone and fine particulate matter and Atlanta is in nonattainment for ground level ozone and fine particulate matter, or $PM_{2.5}$ (ARC, Air Quality). This poor level of air quality will have negative results for the future of the region's economy. According to the Environmental Protection Agency, "Each year, air pollution causes thousands of illnesses leading to lost days at work and school. Air pollution also reduces agricultural crop and commercial forest yields by billions of dollars each year" (ARC, Air Quality). These reduced yields in production will no doubt impact the economy. With businesses under threat of pollution and air quality, Atlanta should be particularly concerned with maintaining a competitive advantage. Forbes, a magazine geared towards interests of business leaders, declares Atlanta is "the most toxic city in the country" (Levy, 2009). According to the article, Atlanta earned this title through a combination of air pollution and atmospheric chemicals. Forbes calculated their statistical analysis by looking at EPA data for the nation's 40 largest metropolitan statistical areas. Variables included: number of facilities that reported releasing toxins into the environment, the total pounds of certain toxic chemicals released into the air, water and earth, the days per year that air pollution was above healthy levels, and the number of times the EPA responded to reports of a potentially hazardous environmental incident or site in each metro area's principle city (Levy, 2009). The Forbes article cites "weak regulations are to blame" for Atlanta's environmental issues. The size of Atlanta's metropolitan area might also contribute to its overall poor air quality for it is not as dense as other metropolitan statistical areas. For a full list of the metropolitan rankings and toxin level reporting, see Appendix A. The same trend is witnessed when focusing in on the airport itself. In comparison to other airports, Atlanta is not among the cleanest facilities. A study that analyzed the emissions impacts of airports reported: "results indicate that Chicago, Los Angeles and Tokyo appear to be relatively clean airports compared with those in Atlanta, London, and Beijing" (Turgut and Rosen, 2010, p. 813). Traffic at Chicago's airport especially is not significantly lower than at Atlanta's Airport. This means that there are measures that can be taken to reduce the negative impacts of aviation activities at HJIA.

The next step is to look at HJIA and its environs and to assess and analyze the current environmental impacts of emissions on regional air quality. The airline industry continues to grow and improve fuel efficiency, yet "the growth in utilization has led to increased harmful impacts to the environment" (Turgut and Rosen, 2010, p. 800). Unfortunately, as mentioned above, Atlanta's "air quality continues to violate national standards and will likely remain in non-attainment in the near future for both ozone and $PM_{2.5}$" (Unal, Hu, Chang, Odman, and Russell, 2005, p. 5788). When considering overall emissions, the aviation industry is responsible for only a small percentage of current emissions. Of all global anthropogenic carbon emissions, the aviation related emissions in aggregate are relatively modest (Freestone and Baker, 2011, p. 270). However, especially important to global warming concerns is the projection of CO_2 aviation emissions to reach up to 300 percent of current levels if no ameliorative action is taken (Freestone and Baker, 2011, p. 273). **Table 1** summarizes the specific environmental aspects that have impacts on the environment and are results of airport operations.

Table 1: The main environmental aspects and impacts associated with airport operations

Environmental Aspect	Environmental Impact
Water consumption	Degradation of human health, ecosystem quality and natural resources
Energy and fuel consumption	Air pollution, global warming
Emissions of CO_2	Global warming
Emissions of VOC	Photochemical smog (increase in ground level ozone)
Emissions of NO_x and SO_x	Acidification and eutrophication
Waste generation	Odour (if applicable), global warming (if biodegradable), air pollution (if incinerated), aesthetical/visual impact, degradation of human health and ecosystem (if improperly disposed off).
Waste water (nitrates, phosphates)	Acidification and eutrophication, degradation of aquatic habitat, soil and groundwater contamination
Heavy metals (Cr, Cd, Ni, Cu, Pb)	Health diseases and soil degradation
Noise generation	Degradation of human health and the biota in the surroundings
Light disturbance	Visual impact on the surrounding community and disturbance of local biota, mainly birds.

Note: CO_2 – carbon dioxide; VOC – volatile organic compound; NO_x – nitrogen oxides; (N_2O) - nitrous oxide, SO_x – sulfur oxides.

Source: Jordão, 2009, p. 23

It is quite evident that Atlanta needs to take measures to reduce the harmful effects of emissions on the environment. To gain a sense of the carbon footprint of the airport, a comprehensive assessment of the airport's contributions to current air quality conditions needs to be analyzed. A 2005 research study conducted at Georgia Institute of Technology looked at the impacts of airport related emissions and the subsequent impacts on air quality. The methodology for the research included detailed modeling that used inventory of the aircraft emissions and other airport-related emissions. The study's method involved performing air quality simulations to relate the emissions to regional air quality around Atlanta using the Community Multi-scale Air Quality Model, or CMAQ. Research was conducted on August 11th through 20th due to the fact that "prior modeling identified this period to be critical for planning purposes … and has a number of days characteristic of high air pollution levels" (Unal et al., 2005, p. 5788). The research concluded the following results (Unal et al., 2005, p. 5797):

- Maximum impact of aircraft emissions on ozone estimated at 56 ppb
- Ozone impact more than 5 ppb over most of the Atlanta non-attainment region
- Maximum impact on $PM_{2.5}$ levels was 25 μgm^-3
- $PM_{2.5}$ impact less than 4 μgm^-3 in most of metropolitan region
- Distribution of emissions spatially was found to impact ozone and $PM_{2.5}$ significantly
- Emissions from ground support equipment impact ozone and $PM_{2.5}$ but to a lesser extent and more locally compared to aircraft emissions

It is important to see the impact on the local and regional scale. However, the concentration of emissions only at the airport area does bring about an equity issue. The people living within close proximity to the airport should not suffer from the negative effects of operations that benefit the overall regional economy.

Significant efforts in technological progress have been made in the last few decades to overcome overall harmful effects of urban air quality. Although, on average, "aviation's share of overall greenhouse gas emissions represents only 3%, the rapid increase [in air travel] observed since 1990 may offset the progress made in other sectors" (Jordão, 2009, p. 22). Increased airport operations should be directly associated with increased investment in mitigating the harmful environmental effects.

Air quality is particularly important due to Clean Air Act legislation. Amendment to the legislation in 1990 allowed for the withholding of funds from the Federal Highway Administration and the Federal Transit Administration if a region's planning efforts do not conform to federal air quality standards (EPA, Clean Air Act). This is particularly disconcerting, for Atlanta could greatly benefit from funding allocated towards public transportation infrastructure. Future metropolitan planning efforts should focus on the continual control of these negative impacts on air quality, especially the sources of ozone and $PM_{2.5}$ emissions.

Global Aviation and the Aerotropolis Concept

In recent years, significant airport area development efforts have been sparked internationally with Dr. John Kasarda's introduction of the aerotropolis concept. Kasarda originally coined the term in 2000, and the concept suggests that a new wave of urban form is emerging through airport-centric development. The basic principle behind the concept is based on economics and the idea that this type of growth offers competitive advantages to metropolitan regions as products and supplies are transported with increased speed and efficiency (Aerotropolis). In terms of defining a successful aerotropolis development, Kasarda states, "If there is not appropriate planning, airport-area development will be spontaneous, haphazard, economically inefficient, and ultimately unsustainable. The aerotropolis model brings together airport planning, urban and regional planning, and business-site planning, to create a new urban form that is highly competitive, attractive, and sustainable" (Aerotropolis). The airport is the theoretical center of the sustainable aerotropolis model. If the airport strives towards exemplifying sustainable practices, then there should be more success in the future of this type of development within the surrounding areas. The driving force behind the aerotropolis is to maintain the efficiency and time factor in business management. Kasarda states, "over a third of the value of all world trade moves by air. This will only increase as global incomes rise and economies shift toward higher-value products that are smaller, lighter and more compact" (Kasarda, 2011, p. 19). He believes that with an increase in goods and services that rely on aviation activities, business will locate closer to airports. Amsterdam's Schiphol Airport is an example of a successful aerotropolis. Amsterdam's aerotropolis exemplifies that businesses consider the attractiveness of the airport area – which is an area of concern for Atlanta. It terms of airport development, it is important for Atlanta to maintain its economic competitive advantage. However, the Atlanta Airport area is "constrained by the unavailability of large area development sites … blight in contiguous communities, failure to prime land through infrastructure provision … and breakdowns in regional cooperation

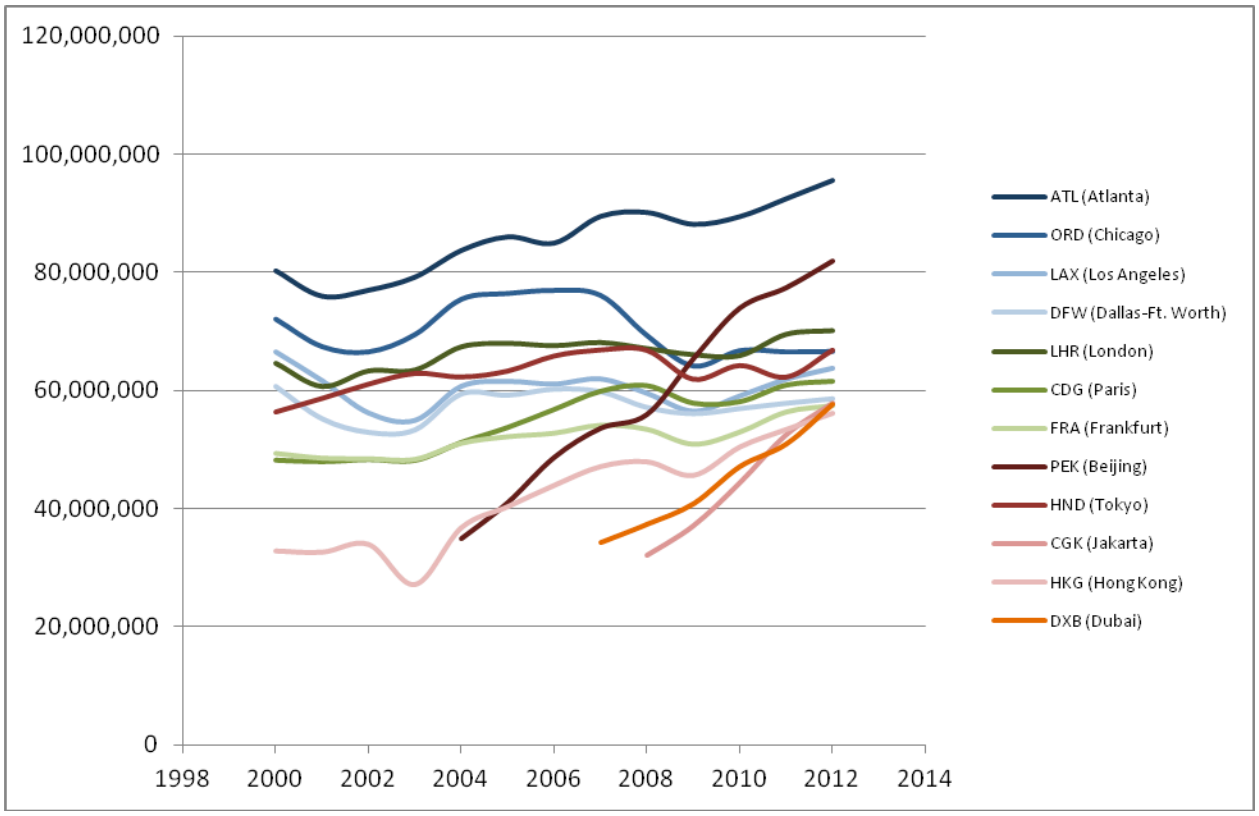
and focus" (Freestone and Baker, 2011, p. 269). Overall, these conditions would not be beneficial in attracting businesses to the airport area. Sustainable practices may help to alleviate some of these negative externalities.

There is controversy over the Aerotropolis concept specifically concerning sustainability. Specifically in relation to the environment, "the greater the scale of aircraft operations, the more inherently unsustainable the situation becomes" (Freestone and Baker, 2011, p. 270). This concern stems mainly from the aviation industry's heavy reliability on fuel. Peak oil is thought to have already passed, and alternative energy sources are quite costly. However, "despite concerns about increasing oil costs and other factors, the aviation industry continues to grow" (Turgut and Rosen, 2009, p. 800).

The aerotropolis concept is based on the theory that industry reliant on aviation is expected to continue increasing and therefore the model assumes unconstrained growth in the aviation industry. Additionally, another serious implication is that "some regional economies can become too dependent on air traffic, causing vulnerability in periods of downturn" (Freestone and Baker, 2011, p. 270). Kasarda's concepts follow along with business as usual criteria, yet "the consequence is that large investments in the business-as-usual aerotropolis assume the ongoing viability of current air transport technology and are thus likely to be misguided in the long term" (Chang, Barnes, Ryan and Clayton, 2007, p. 1024). These concerns suggest that there should be limits to growth within an airport region. To avoid these critical concerns, aerotropolis development should be guided with careful and informed planning.

As mentioned, in today's globalized world, there is a trend for businesses to locate in areas with easy access to the airport. The increase in global aviation operations reflects this desire for people and products to move quickly across states, nations, and countries all over the world. Information on passenger statistics provides insight on how Atlanta compares to other international airports within the global context. In terms of numbers of passengers, Atlanta has ranked highest for several years.

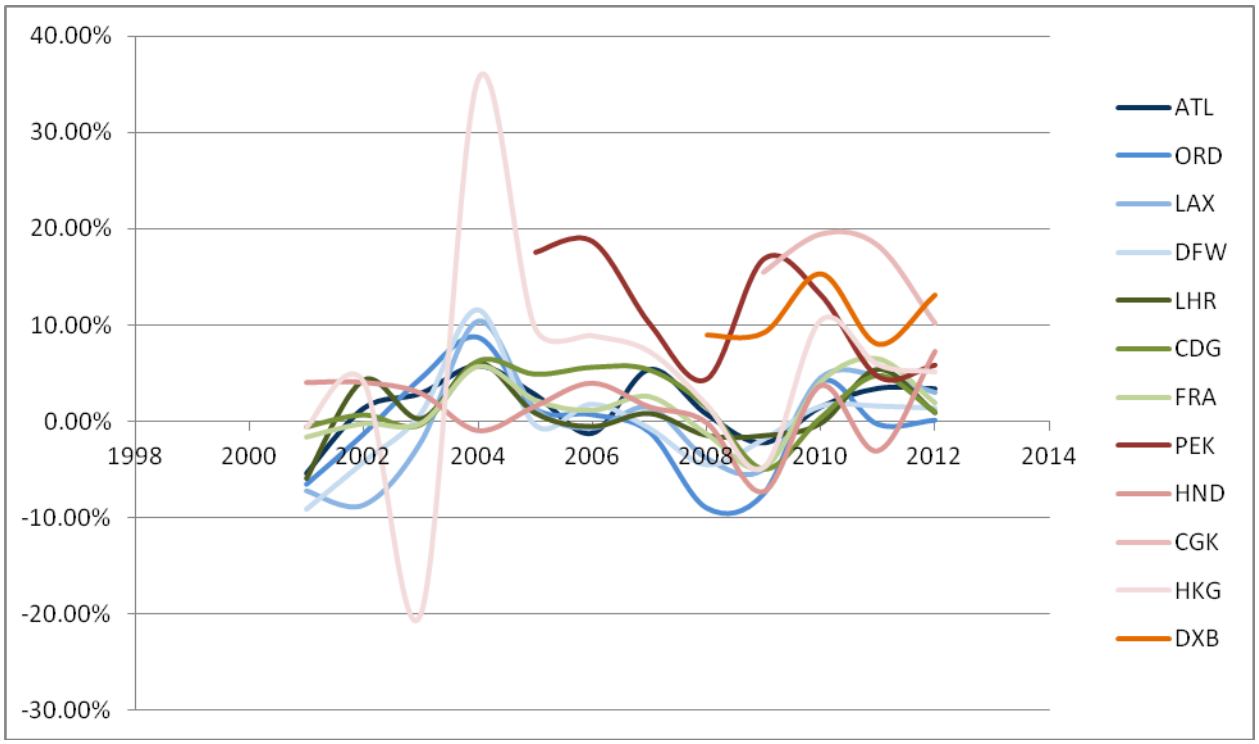
Figure 2: Passenger traffic trends from 2000 to 2012 for the top 12 busiest airports in 2012



Source: Airports Council International; Chart compiled by author.

Figure 2 shows the trends in passenger traffic from 2000 to 1012 for the top 12 busiest airports in 2012. Airports located in North America are shown in blue shades, airports located in Asia are shown in red shades, and airports in Europe are shown in green shades. Overall, growth trends for American airports appears to be rising steadily. Passenger traffic at Asian airports is increasing quite rapidly. Many Asian counties have also invested in building modern airports with superior infrastructures. The emerging Asian market has the potential to encroach on Atlanta's territory of having the busiest airport. To maintain its competitive advantage, Atlanta needs to follow suit and invest in its airport infrastructure and overall integrated transportation network. Precedents in Asia, particularly the aerotropolis developments of Incheon, Hong Kong, and Changi, provide good examples.

Figure 3: Rates of changes in passenger traffic from 2000 to 2012



Source: Airports Council International; Chart compiled by author.

Figure 3 illustrates the percentage changes in passenger traffic for each of the airports shown in **Figure 2**. The chart depicts that the airports in Beijing (PEK), Jakarta (CGK), and Dubai (DXB) are experiencing the greatest changes in passenger traffic – therefore indicating a growth in the markets surrounding these airports. Although Atlanta's passenger traffic is stable and climbing, the emerging economies of the Middle East and Asia could one day stabilize or reverse this trend.

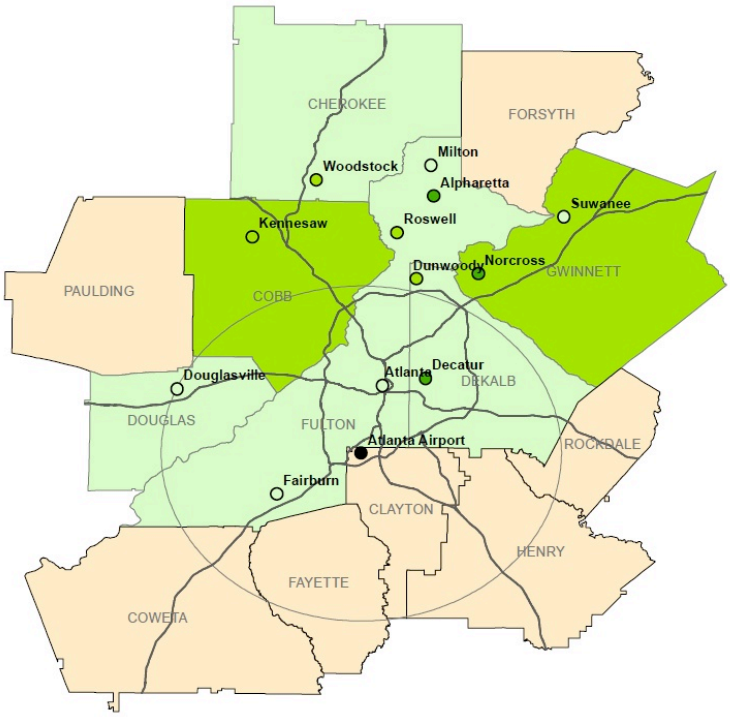
Atlanta Airport Area

There is significant disparity between the economic development on the north side of Atlanta and the south side of Atlanta. This spatial economic disparity is particularly perplexing because "air transportation plays a substantial role in global economic activity," yet Atlanta's airport is located on the opposite site of the metropolitan area's economic growth regions (Unal et al., 2005, p. 5787). Many Fortune 500 businesses have located their global headquarters in the Atlanta metropolitan region. However, these businesses

tend to locate in the northern areas of the city such like Buckhead, Perimeter, and Cumberland.

Looking at 2010 U.S. Census data of the Atlanta metropolitan region provides insight into the spatial disparity between the areas in the northern and southern hemispheres of Atlanta Airport's 20-mile radius metropolitan region (Leigh, 2012). The demographic data shows that the "southern crescent" contains a higher minority population, lower median household income, and a higher unemployment rate. This data is generalized, and there are outliers, but the overall conclusion is that there are definite trends that suggest Atlanta's southern half experiences economic disadvantages. There is a spatial mismatch in that one of the region's main economic powerhouses, the Atlanta airport, is located within the "southern crescent." During the past few years, the aerotropolis concept has been identified as a strategy to increase economic development and the competitive advantage of this region.

Figure 4: Certified Green Communities in Metropolitan Atlanta



Source: ARC, Green Communities; Graphic compiled by author.

The map above further illustrates disparities in investment. The circle designates the 20-mile radius around the airport area. The color-coded counties and cities signify areas certified under the ARC's Green Communities Program. The program encourages local governments to become more sustainable (ARC, "Green Communities"). The areas outlined in darker shades of green designate Gold level of achievement. The areas coded in a medium green shade attained the Silver level, and the pale green areas have attached Bronze level of achievement. It appears that trends in sustainable development are concentrated towards the northern end of the airport area.

Over the past months, the Atlanta Regional Commission has held Atlanta Airport Area Task Force meetings in an effort to bring together stakeholders to collaborate on ideas to help create a better airport region. As of March 2013, they have created the Atlanta Aerotropolis Alliance. This organization is "looking to add some corporate heft behind its efforts to craft a strategy for development around Hartsfield-Jackson Atlanta International Airport" (Williams, "Aerotropolis Alliance," 2013). The group is determined to bring together businesses, property owners around the airport, elected officials, colleges and universities, and other nonprofits to create a framework for development through a public-private partnership. Recent strides for the Task Force include representation at meetings from important corporate stakeholders: Delta Air Lines and Coca-Cola. Other businesses, such as Porsche, Siemens, Prologis, and Duke Energy, are also taking interest in Atlanta airport development (Williams, "Aerotropolis Alliance," 2013). Louis Miller, the HJIA's general manager, states, "the Atlanta airport can't create an airport city on its own grounds, nor does it have the authority to actively drive development 'outside the fence'" (Williams, "Aerotropolis Alliance," 2013). HJIA can however work in cooperation with development drivers and incorporate practices that ensure better community relations.

What is Sustainability?

The concept of sustainability as it is known today originates in the 1980's through collaboration of the Brundtland Commission, a unit of the United Nations. The 1987 World Commission on Environment and Development witnessed the origins of defining the term: "Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future." Thereafter, sustainability has encompassed conceptual ideas that focus on land development needs of the present

and future. According to the Environmental Protection Agency, sustainability is based on the following principle:

> "Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations" (EPA, Sustainability).

Sustainability is perhaps considered by many to be a buzzword for environmental and green development. However, sustainability includes a wider perspective on several societal aspects. Sustainable development not only addresses current needs, but also assesses all aspects of civilization to ensure lasting results that will have positive implications on future generations.

Sustainability may encompass many types of development. According to a study on sustainable development, "the problem is that no clearly agreed understanding exists as to what exactly is to be sustained" (Longhurst, Gibbs, Raper, and Conlan, 1996, p. 197). To make the concept easier to decipher in relation to an airport area context, this research uses three categories of sustainable development. As mentioned in the introduction, these categories are based on the FAA's recommendations for sustainable airport practices: environmental, economic, and socially sustainable practices.

These categories are often cited when assessing sustainable developments. Today this is often viewed as a "triple bottom line approach." This phrase was coined by John Elkington and defines an approach that captures the spectrum of valuing organizational or societal success on people, planet, or profit. Elkington states: "for an organization to be sustainable – a long run perspective -, it must be financially secure, it must minimize (or ideally eliminate) its negative environmental impacts and, finally, it must act in conformity with societal expectations" (Elkington, 1994). The values provide a framework in identifying innovative sustainable strategies that may be implemented at Atlanta's Airport.

Why Should Airports be Sustainable?

Airports are considered by many to bring about harmful effects to the environment. This judgment is heightened by the fact that the "negative impacts on the environment and human beings are visible. The combination of these two observations leads to the question of whether 'sustainable' aviation is possible" (Boons, van Buuren, and Teisman, 2010, p. 303). When considering the topic of airport sustainability, one might question: what

motivates airport operators to improve their sustainable performance? The Airports Council International North America (ACINA) defines airport sustainability as: "A holistic approach to managing an airport so as to ensure the integrity of the economic viability, operational efficiency, natural resource conservation and social responsibility of the airport" (Airports Council International, 2006). Airports are by nature energy intensive facilities. However, information and technology is available to significantly reduce negative externalities.

The ACRP's 2008 report on Airport Sustainability Practices states that "state, regional and federal regulations [are] key drivers for implementation of sustainability practices at airports, along with airport policies, corporate responsibility, and stakeholder concerns/relation" (p. 9). These concerns, however, cover the current drivers for sustainable efforts. The future of the aviation industry is important, and investment in infrastructure for the sake of the future is often necessary. This investment in infrastructure is not intended to focus on new construction and facility expansion. Moreover, there should be increased attention on alternative energy sources and public transportation infrastructure. For the future of airport sustainable planning efforts, the ACRP report suggests the following through its survey findings as areas of concern: "For the future, global issues such as climate change were identified as the most common drivers for implementation of airport sustainability practices and programs" (ACRP, 2008, p. 9). This signifies a necessity for airports to invest in infrastructure that will assist in minimizing carbon footprints.

Due to their important function within the greater urban context, airports are an important part of a city's vitality. Interestingly, airport planning "literature remains a specialized niche within a more prodigious stockpile of technical investigations into airport issues, surprisingly so given the increasing interdependence of aviation, urban and environmental issues since the 1960's (Stevens, Baker, and Freestone, 2010, p. 277). For example, numerous technical studies exist that analyze airport noise pollution on surrounding communities. Although these technical studies provide interesting insight, certain airport planning criteria remain under-researched. It appears that there is a need to quantitatively analyze spatial trends in airport development and how these relate to planning policy.

Table 2: Trends in airport development and planning

Decade	Research and Planning Efforts in Airport Development	Atlanta Airport Efforts
1920's	1928: First literature on air field development	1925: origins of airport development (Candler Field)
1930's	Focus on air transport as link to transportation infrastructure 1937: Civil Aeronautics Board regulates domestic interstate air transport	1930: Delta Air Service begins commercial airline service 1930's: airport developed into third busiest in nation with service from Delta Air Lines and Eastern Air Lines
1940's	Airport part of national infrastructure, yet development not an issue of concern Post WWII: in Europe and US most airports handed over to local and regional municipalities	Candler Field used as military airfield (airport doubled in size) 1946: Atlanta Municipal Airport
1950's	Appreciation of post-military potential of aviation in national development 1950's – 60's: many countries transferred ownership to civil aviation authorities	1956: first international flight Atlanta becomes busiest airport in the world
1960's	Evolution of airport into economic zone and development of airport industrial parks	1961: new terminal to alleviate congestion (largest in the county and could accommodate 6 million travelers a year) 1964: First scheduled nonstop international flight 1967: First airport master plan for future development of Atlanta Municipal Airport
1970's	Airports as new suburban centers that serve as nexus between producers and suppliers, companies and clients, and headquarters and branch offices, Research focused mainly on expansion plans 1978: Airline deregulation	1977: Construction began on present midfield terminal
1980's	Increased interest in environmental and noise issues Decreased trend in state funding for airports 1987: UK first to privatize airport ownership	September 21, 1980: Opening of William B. Hartsfield Atlanta International Airport 1984: Fourth runway expansion 1985: extension of another runway
1990's	Research focused on impacts of deregulation	1994: Concourse E opens in preparation for Olympics 1999: Development Program: "Focus On the Future" – construction projects to handle passenger projections and airport development through 2015
2000's	Liberalization of aviation sector and economic development	2003: Renamed to Hartsfield-Jackson Atlanta International Airport

		2006: Fifth runway expansion complete 2007: End-around taxiway 2007: Drought causes airport to make changes to reduce water usage 2009:Rental Car Center
Current	Research focused on human scale and mobility	2012: New International Terminal 2011 – 2014: Modernization of Concourse D

Source: Freestone and Baker, 2011 & HJIA, Sustainable Management Plan, 2011; Compiled by author.

Table 2 summarizes trends in airport development and relates these trends to the Atlanta Airport context. Current airport sustainability efforts are driven by the culmination of trends in airport development over the last few decades. In the 1950s, airports and their surrounding areas became points of concern. Noise complaints and community encroachment emerged as topics in planning discussion. However, according to the Report of the President's Airport Commission in 1952, airports received little attention from the planning world over the issues concerning their physical relationship to urbanized environments , Freestone and Baker, 2011, p. 264).

Following the national environmental movement in the previous decade, the 1970s witnessed a sharp increase in concerns over the environment, especially in political agendas. During this time, various definitions for sustainable development began to emerge (Longhurst et al., 1996, p. 197). The Atlanta Airport follows along closely with the airport development trends highlighted in **Table 2**.

Current and Future Efforts in Airport Sustainability

Current airport dialogue and controversy is centered on the topics of sustainability in terms of its social, economic, and environmental implications, and balancing these goals within the growth of an airport in its civilian context. Many argue that sustainability cannot be defined within a specific framework; rather it is defined through a process that takes into consideration stakeholders and the community's desires. Airports are constantly mediating actions between local and global forces. As John Short states, "airports are not just nodes in the global network of flows; they are sites of major environmental impact that highlight the tension between international connectivity and local livability" (Short, 2004, p. 72). People who live within the airport area should not shoulder the negative costs of airport related activities. To alleviate tensions and promote sustainable practices, the Federal Aviation Administration began the Sustainable Master Plan Pilot Program in 2009. Through this program the FAA has funded long-range planning efforts at numerous airports in the region – including the Atlanta Airport[1].

In its 2008 report on sustainable airport practices, the Airport Cooperative Research Program, a unit of the Transportation Research Board, surveyed 25 national and international airports to obtain information on existing practices. The report states: "Seventeen of the 25 survey respondents said that their airport does not currently invest in economic or social sustainability research" (ACRP, 2008, p. 32). This highlights a necessity to place increased emphasis on researching economic and social sustainability practices.

From the global perspective, it is evident that American airports need to invest in improving their airport infrastructure. As was highlighted in the previous section discussing global aviation, airports in the Middle East and Asia are growing rapidly. Kasarda highlights this by pointing out that "the World Economic Forum ranks the quality of United States aviation infrastructure 31st in the world, tied with Thailand and behind such nations as Malaysia, Panama, and South Africa" (Kasarda, 2011, p. 19). Kasarda continues to stress the lack of investment by pointing out that the President's $50 billion infrastructure stimulus package only allocates $2 billion to airports (this is only 4% of the total funds allocated). Kasarda also states that China is investing $240 billion into the airport sector during the next five years (which includes 56 new commercial airports), India is building 20 new airports and modernizing 58 others, and the Middle East is investing $104 billion in its airport infrastructure (Kasarda, 2011, p. 19). The United States' investment blatantly does not compare to efforts initiated in emerging economies.

[1] For a complete list of all airports participating in sustainable master planning, see http://www.faa.gov/airports/environmental/sustainability/

Airport area development and sustainability may appear to be somewhat of a contradiction. A lot of controversy regarding airport area development is centered around the "divisive clashes between actors that advocate economic growth and those that prioritize quality of life for those living in close proximity of the airport" (Boons et al., 2010, p. 303). However, airport sustainability is focused on promoting economic development within the airport area. Airport area development stresses bringing about new growth, which oftentimes brings additional negative environmental impacts. However, it is important to note that sustainability is not solely focused on promoting zero waste and energy reduction. For purposes of this research, focus will be centered on a holistic perspective that strives to create a better world for all, today and in the future. Economic growth ensures better quality of life. To negate the equity issue of people living within an airport area, the economic development needs to work around their needs and resident opinions should be polled and considered.

In all aspects of sustainable airport development, regardless of environmental, social, or economic, stakeholder engagement is key. Stakeholders provide a basis on which contradictory statements could potentially be judged. The following excerpt sums up the importance of stakeholder engagement:

> "Following the seeming contradiction arising from the pursuit of different routes to sustainability, and the inability of market forces and regulatory instruments, respectively, to solely address market failures, it becomes quite necessary for policies and decisions to be based on broader perspectives in order to attain some sort of balance, across the board" (Amaeshi and Crane, 2006, p. 247).

Stakeholders come from all different types of backgrounds and have motives driven by all types of forces. By taking into consideration all possible viewpoints, a better and more sustainable airport area emerges. For successful operations, dialogue needs to move beyond a debate in which "sustainability is reduced to a balance between the interests of the citizens and the further growth of the airport" (Boons et. al., 2010, p. 303). It is important to note, dialogue between airport operators and stakeholders needs to be cooperative on both sides. Like the incremental approach to problem solving that is used in planning literature and practice, the sustainable approach is a process.

ENVIRONMENTALLY SUSTAINABLE PRACTICES

HJIA's *Airport Master Plan* lists the total enplanements at 46,332,795 for 2011. This number is project to reach 60,331,400 by 2031. It is evident that the aviation sector will grow, yet "no matter which growth performance is expected by civil aviation industry, the sector has already achieved such a high level of passenger traffic and cargo volumes that it has raised serious concerns of community members and local or state agencies regarding the associated environmental impacts of airlines and airline operations" (Jordão, 2009, p. 22). This increase in travel will no doubt have significant impact on the environmental quality of the Atlanta Airport and its surrounding community. However, "If not addressed, environmental impacts may well be the fundamental constraint on air transportation growth in the 21st century" (Waitz, Townsend, Cutcher-Gershenfeld, Greitzer, and Kerrebrock, 2004, p. 3). There are several different directions in which an airport may address these environmental concerns. The following are the categories of environmentally sustainable efforts as outlined by ACRP's *Airport Sustainability Practices*: measurement and monitoring, water, water quality, air quality, climate change, biodiversity, materials, waste management, noise, pollution and aesthetics, energy, and green building.

Some critics state that environmental sustainability is often "operationalized in terms of the amount of waste and emissions produced" and "reduction of these is taken as an increased sustainability" (Boons et al., 2010, p. 304). Measuring reductions provides a way to quantify sustainability, yet these techniques may provide disillusionment on the grounds for the greater cause of sustainable efforts. Many airports, including Atlanta, have started numerous efforts in minimizing waste, recycling, and noise reduction. This report attempts to go beyond the basic measures that have been implemented to pinpoint innovative measures that may be applicable to the Atlanta Airport context. Based on the inventory of measures highlighted in ACRP's 2008 *Airport Sustainability Practices* a few innovative techniques have been extracted below to gain a sense of advanced measures taken elsewhere[2]. Practices already implemented at HJIA are not included in the following categories.

Measurement and Monitoring:

- EMS certified to ISO 14001
- Global Reporting Initiative guidelines

[2] Atlanta's HJIA was not included in the 25 airports that submitted survey responses to the *ACRP Synthesis 10* report.

Water:

- Computer-controlled, "smart" irrigation systems
- Green roofs and limited landscaping that features xeriscape and drought-tolerant species

Air Quality:

- Partnering with research institutions and resource agencies to address air quality issues
- Transport Demand Management (strategies or policies to reduce or redistribute automobile travel demand)

Climate Change:

- Improve passenger access through comprehensive public transportation network
- Aircraft emissions charge – the most highly polluting aircraft incur the highest charge
- Research and Partnership: active participation of airport staff in local, regional, state, and national climate change research and programs

Land Use:

- Land Use Planning: Plans to partner with the community on an airport-centered eco-industrial zone
- Incorporating greenspace as much as possible in future developments

Biodiversity:

- Nonlethal Bird Techniques: noise systems to scare birds; habitat management and landscaping that is not attractive to birds; monitoring and movement of birds away from aircraft; managing unsealed areas of the airport as extensive grassy meadows to prevent collisions between aircraft and birds
- Habitat Protection or Enhancement: Designate areas for nature conservation zones and financially supported as ecological compensation measures, woodlands, and bodies of water; wildlife hazard management plan; wetland mitigation program; vegetation management; contract with U.S. Department of Agriculture; partnership with the local conservation group

Green Building Practices:

- Solar photovoltaic panels
- Native ground landscaping using trees grown in local nurseries

ECONOMICALLY SUSTAINABLE PRACTICES

Airports can often be economic powerhouses for their surrounding communities. They are key components in bringing together people and supplies – the basic components of economic development. Not only are airports large direct employment centers, but they also have indirect economic impacts "in the chain of suppliers providing goods and services. In addition, the incomes earned in these direct and indirect activities generate demand for goods and services in the economy, which supports further employment" (Jordão, 2009, p. 24). As was mentioned earlier in the section defining sustainability, the term refers to the efficient allocation of resources. These efficiencies are directly related to local hiring and purchasing. If an airport upholds economic efficiency, then it "maintains and enhances a region's international competitive advantage in high value-adding growth and core industrial sector and their support industries" (Stevens et al., 2010, p. 289). This echoes the ideas discussed earlier on the Aerotropolis concept. The categories below provide and overview of innovative techniques that address economic sustainability (ACRP, 2008).

Local and Responsible Economic Practices:

- Local hiring by airports and tenants
- Purchase of goods and services from local and environmentally friendly businesses

Community Contributions:

- Use community programs as part of staff training and development
- Improve its reputation and profile

Sustainable Research and Development:

- Airport to form a regional coalition of similar-sized organizations to benchmark each other's sustainability initiatives

Incentives for Sustainable Behavior:

- Financial Incentives: airport subsidized public transport buses and bus rapid transit to all terminals**;** provide incentives to carpool/bus/bike to work
- Non-financial incentives: raise employee awareness through website/pamphlets

A 2009 study that provided an assessment on the best sustainable practices at airports concluded that improvements in economic sustainability are measured by: "increase on revenues per passenger and revenues per employee, increase on dividend payouts for

shareholders, decrease of fines per year for incidents of non-compliance with local regulations, increase in passenger traffic and aircraft movements" (Jordão, 2009, p. 31). The study suggests that airports are able to increase overall profits if some of the above measures are implemented. Additionally, the extra revenue could be allocated towards environmental efficiency projects that can sometimes be quite costly.

SOCIALLY SUSTAINABLE PRACTICES

In terms of airport practices, social sustainability aims to improve interactions with all stakeholders, including passengers, employees, airlines, and residents of neighboring areas (ACRP, 2008, p. 34). The well-being of all stakeholders should be taken into consideration in airport planning and development processes. For corporations, social responsibility has been a trend over recent years. According to a 2009 study on sustainable airport practices, "there is a consensus nowadays that socially responsible business means going beyond compliance with relevant legislation and continuously investing into human capital, environmental protection and relations with stakeholders" (Jordão, 2009, p. 25). Involving stakeholders at all levels particularly ensures successful socially sustainable practices. Airport-related stakeholders may include the following: investors, employees, passengers, industry associations, airline companies, local authorities, journalists and local communities (Jordão, 2009, p. 25). However, from the business perspective, stakeholder engagement often means a higher chance of opposition and the potential for eventual termination of projects. For many airport-planning projects, the "challenge arises from the conflict and inevitable trade-offs amongst the varied strands of sustainability propositions… The reality of these difficulties, however, does not constitute a strong reason to drop the stakeholder engagement approach" (Amaeshi and Crane, 2006, p. 256). When concerned and interested parties are involved at all stages of planning and development, there appear to be higher levels of successful project implementation. Communication needs to be transparent and facilitated so that all voices may be heard and considered. The categories listed below include innovative techniques outlined in *ACRP's Synthesis 10* that have been implemented at airports worldwide to ensure socially sustainable practices (2011).

Stakeholder Relationships:

- Federal, State/Regional, Local Government: regular communication
- Passengers: search for ways to improve services and systems to meet customer needs and desires

Transportation:

- Efficient access to public transit across multiple modes
- Pedestrian/cycling infrastructure

Accessibility:

- Disabled/elderly persons

Local Identity, Culture, and Heritage:

- Express identity through heritage, art, and culture

Indoor Environmental Quality:

- Maximize use of sunlight.

Employee Well-Being:

- Sport facilities; fitness club
- Green space

Passenger Well-Being:

- Internet access
- Golf course, banks, shops, post office, spa facility, fitness club
- Planters and open green space/park and nature trail near airport/ dog walking park
- Quiet rooms/meditation rooms/sleeping facility
- Child play areas

John Kasarda states, "Employment growth near airports has been growing considerably faster than the metropolitan suburban area in which the airport is located" (Kasarda, 2007, p. 7). However, the economic disparity of the "southern crescent" in which the Atlanta Airport is located does not match this trend. Unemployment is higher around the Atlanta Airport area. If the airport implements socially sustainable practices and begins to hire locals, as well as create additional jobs for locals, then the airport area should begin to see significant improvements in quality of life.

Additionally, in Kasarda's writings, he frequently cites the emergence of increased airport offerings and amenities. Many of these offerings are listed in the Passenger Well-Being category above. However, assessment of needs is vital before planning for innovative airport amenities. The most common way of assessing passengers' needs is through surveys. An example of a business specializing in this surveying process is London-based Skytrax, which has been ranking the world's best airports since 1999. The rankings are judged based on surveys that are conducted in 190 airports worldwide on every day of the week. There are 39 evaluation criteria that can be viewed in Appendix A. **Table 3** summarizes the Skytrax rankings for the top ten world's best airports for the last four years.

Table 3: Skytrax rankings for top 10 world's best airports (2009 – 2012)

	2012	2011	2010	2009
1	Incheon International Airport (South Korea)	Hong Kong International Airport	Singapore Changi Airport	Incheon International Airport (South Korea)
2	Singapore Changi Airport	Singapore Changi Airport	Incheon International Airport (South Korea)	Hong Kong International Airport
3	Hong Kong International Airport	Incheon International Airport (South Korea)	Hong Kong International Airport	Singapore Changi Airport
4	Amsterdam Schiphol Airport	Munich Airport	Munich Airport	Zurich Airport
5	Beijing Capital International Airport	Beijing Capital International Airport	Kuala Lumpur International Airport	Munich Airport
6	Munich Airport	Amsterdam Schiphol Airport	Zurich Airport	Kansai International Airport (Japan)
7	Zurich Airport	Zurich Airport	Amsterdam Schiphol Airport	Kuala Lumpur International Airport
8	Kuala Lumpur International Airport	Auckland International Airport	Beijing Capital International Airport	Amsterdam Schiphol Airport
9	Vancouver International Airport	Kuala Lumpur International Airport	Auckland International Airport	Centrair Nagoya (Japan)
10	Central Japan International Airport	Copenhagen Airport	Bangkok Suvarnabhumi Airport	Auckland International Airport

Source: Skytrax, 2013; Data compiled by author.

When looking at the complete ranking of the world's twenty best airports, not a single United States airport is listed. The top U.S. airport, based on the Skytrax passenger surveys, is Cincinnati/Northern Kentucky International Airport, which took 24th place. Of the five case study airports that are analyzed later in this report, three are listed within top 10 for 2012 (Changi, Amsterdam, and Zurich). Additionally, all three of these airports consistently appeared in the top ten rankings for at least the past four years, if not more. The other two case study examples, Chicago and Boston, are ranked 86th and 94th, respectively. Atlanta's airport is ranked 59th best in world in 2012. According to a study, "evaluation methodology proposed by Skytrax has been shown to be consistent based on the perspectives of the customers, i.e., the passengers" (Jordão, 2009, p. 25). This suggests that the rankings provide viable data in assessing potential projects that would enhance passenger well-being. About 75% of HJIA passengers only transfer between aircraft on the airside parts of the terminal (Freestone and Baker, 2011, p. 269). This statistic suggests that innovations in amenities within the concourse spaces could provide more positive passenger feedback.

Additionally, the Airports Council International employs the benchmarking program Airport Service Quality (ASQ). Under this type of evaluation, data is gathered through

observation that is scheduled to maximize collection of key issues during peak operating hours. The ranking results using this method closely reflect the results of the Skytrax method (Jordão, 2009, p. 25).

Additionally, in terms of measuring improvements in social sustainability certain quantitative data can be gathered and measured over time to document changes. This may include increased usage of public transportation, and increase in airport-related employment, and reduction in the number of complaints over a certain time frame. In a broader context, other indicators are important in evaluating not just the airport facility's social sustainability, but also the social sustainability in terms of the airport area. Recalling the earlier discussion on stakeholder engagement, this would require outreach and communication with local communities, employees, corporations, and other service providers.

Airport Sustainability and Policy

There are many guidelines that provide information on airport sustainability best practices. Recommended by the FAA, SAGA[3] provides airports across the Unites States with a database that assists in airport planning, implementing, and maintenance of sustainable programs.

GRI is a United States based non-profit organization that provides guidelines to address concerns and expectations of stakeholders. The purpose of these guidelines is to "improve effectiveness in managing, measuring, and communicating on the impacts of airport operations on the natural and social environment which in turn will ensure the prosperity of the business in a long-term" (Jordão, 2009, p. 25). GRI guidelines are tailored for different industry sectors to enhance communication and to better integrate sustainable practices into overall business operations.

[3] For more information on SAGA see http://www.airportsustainability.org/

Barriers to Sustainability

Sustainable projects often require capital investment, particularly for the planning processes. Some projects require heavy financial backing and will need to be supported through innovative funding. Steve Howards of the consulting firm Clean Airport Partnership states, “Because of the precarious situation in airlines, airports require quick return on investment. Sometimes the return on investment on these (environmental) projects is not quick enough for the airport” (Yu, 2008, Sept. 16). Even if regional motivation for sustainable planning exists, oftentimes there is a lack of funding to support these operations.

In addition, regional governments and municipalities often are opposed to airport-led development measures. The main reason behind the opposition is that there are regional concerns about the diversion of economic assets to the airport area. A city center within a greater metropolitan region wants to retain its competitive advantage and concentrate job growth within the traditional central business districts.

Also, many businesses located within the airport to not support sustainable initiatives. For example, airlines do not typically support costly investments in airport infrastructure. The airlines fear that costs for leasing space within the terminals will increase with an increase in development expenditures.

Atlanta's Hartsfield-Jackson International Airport

Currently, Atlanta's Hartsfield Jackson International Airport has set in place several sustainability programs. These include minimizing waste, recycling, air and water quality initiatives, and energy conservation. The airport has also recently completed the Sustainable Management Plan in 2011. Atlanta's new international terminal has achieved LEED Silver certification. However, in a broader context, efforts at the Atlanta Airport do not quite compare to innovative sustainable techniques and practices that have been implemented at other progressive airports. European and Asian airports particularly stand at the forefront of sustainable and innovative green design. Other United States airports that have implemented noteworthy efforts in sustainable airport practices include Boston's Logan Airport, Chicago's O'Hare Airport, Denver's Airport, San Francisco's Airport, the Dallas/Fort Worth Airport, and New York's J.F.K. Airport. Five of these airports are included in the top seven busiest airports in terms of passenger traffic in the United States, yet Atlanta is not among them.

The Atlanta airport is not only important for the City of Atlanta, but also has a significant impact on a broader regional context and serves as an important connection to the rest of the world. The Atlanta Business Chronicle states, "Being home to the world's busiest airport has always has its perks, but the benefits just keep getting better for metro Atlanta and Georgia" (Atlanta Business Chronicle, 2010). Past statistics show that this is continually an area of job growth. These are interesting statistics to consider, especially when recalling the earlier discussion on the Atlanta Airport area suffering from higher rates of unemployment.

In 2000, "the airport's direct employment was about 44,000. That was before the 9/11 disaster, which put the aviation industry in a tailspin" (Atlanta Business Chronicle, 2010). The total was up to 56,505 in 2005 and 58,000 in 2009. This means there was a 28% change in job growth between 2000 and 2005, which was a particularly difficult time for the airline industry. Additionally, the airport's 2009 Economic Impact Study revealed a 3% job growth between 2005 and 2009. Direct jobs refer to the jobs that are directly connected to operations at the airport facility. Indirect jobs are generated through services provided by other firms, vendors, and businesses in the area. The total number of indirect jobs resulting from operations of the airport was 33,204 in 2009. In addition, the spending of airport related wages produce induced jobs, which totaled to 59,047 in 2009. Air cargo related operations contributed 31,385 jobs in 2009. Also, the impact of visitor spending contributed 252,742 jobs through patronage at local hotels, restaurants, retail stores, recreation, and local transportation. This means that as of 2009, the Atlanta Airport had a total impact on 434,434 jobs (Hartsfield-Jackson International Airport 2009).

According to the Airport's Sustainable Management Plan, "If the airport is to keep its present position as a leader in the global air transportation industry and further expand its role in Georgia's economy, it will continue to ensure that growth is compatible with the environmental and economic needs of surrounding communities" (Hartsfield-Jackson International Airport, Sustainable Management Plan, 2011). Atlanta's Airport is moving in the right direction, but there is still blight in the immediate airport environs.

In terms of monetary impact, the airport contributes approximately $32.6 billion dollars in direct business revenue to metropolitan Atlanta. This figure totals $35.6 billion dollars for the state of Georgia as a whole. For comparison, in 2005 the direct business revenue was $23.5 billion for metropolitan Atlanta and $26.6 billion for Georgia. This means that the direct business revenue increased by 39% for Atlanta and by 34% percent for the greater region of Georgia (Hartsfield-Jackson International Airport 2009).

Image 1: Aerial View of Hartsfield-Jackson International Airport

Source: Google Maps, February 2013

Atlanta Airport Statistics

As mentioned earlier, Atlanta has the world's busiest airport. In 2011, 92,365,860 passengers traveled through Atlanta (Hartsfield-Jackson International Airport, Annual Financial Report, 2011). The airport has 19% more passenger traffic than the second busiest airport (which is Beijing Capital International Airport at 77,403,669 passengers in 2011). The second busiest airport in the United States is O'Hare International Airport in Chicago with 66,561,023 passengers (39% less than Atlanta). However, it is important to note that Chicago has a second airport within its metropolitan area. Chicago's Midway International Airport had a total of 15,672,688 passengers traveling through the facility in 2011. This brings the combined Chicago metropolitan area passenger traffic count to 82,233,711 in 2011. This total passenger count is only 12% more than Atlanta's total.

It is important to note that a high number of passengers does not ensure that the airport serves as a regional economic activity center. This occurs because "hub status does not necessarily translate to significant airport-centric development" (Freestone and Baker, 2011, p. 267). The previous section mentions that 75% of HJIA passengers are on a layover. These passengers never exit the airport and have little to do with the airport area's overall economy. This is highlighted by the following data: "Atlanta employs about 70,000 nongovernment employees or roughly 4.1 percent of the metropolitan nongovernment workforce. The Dallas-Fort Worth airport economic zone comprises over 100,000 workers distributed among 2,600 firms" (Freestone and Baker, 2011, p. 267). The Las Colinas aerotropolis is in proximity to the Dallas-Fort Worth airport and is frequently cited as a good example of airport-centric development. Perhaps if HJIA were in close proximity to more upscale planned business development, then it would experience positive economic impacts.

Background

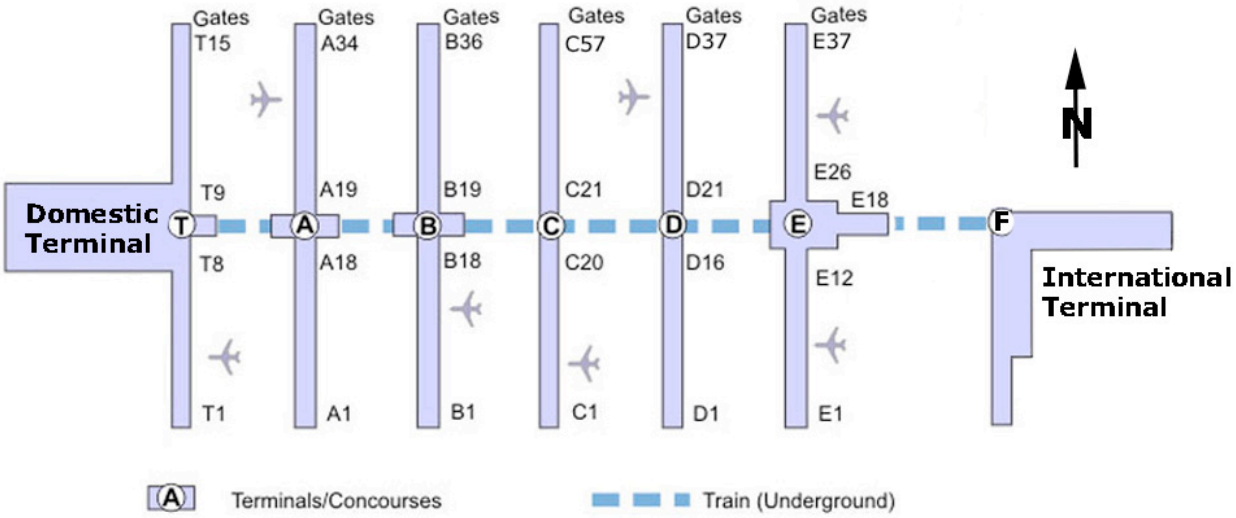
Atlanta's airport origins may be traced back to 1925, when an airfield space opened on land that was once owned by the The Atlanta Speedway. The airfield would later be known as Candler Field, and was renamed Atlanta Municipal Airport in 1946. Increased air-travel traffic and planning efforts in the 1960's contributed to the fruition of Hartsfield-Jackson's current facility. Construction began in January 1977 at a staggering cost of $500 million. Atlanta's current airport facility opened on time and under budget on September 21st, 1980 and is run by the City of Atlanta's Department of Aviation. The facility was designed to accommodate up to 55 million passengers per year and covered 2.5 million square feet. Additional renovations to the structure included the 1984 fourth runway addition and a 1985 runway extension. Concourse E was added in 1994. Additionally, plans for the

construction of a new international terminal began in 2003. Construction began in the summer of 2008, and the new LEED-certified facility opened on May 16th, 2012. Current initiatives at the airport are to expand sections of the midfield taxiway to accommodate the large Airbus A380 aircraft and the modernization of Concourse D. The runway expansion project is scheduled to conclude in August 2013, and the concourse renovations are to be completed in the spring of 2014 (HJIA, Sustainable Management Plan, 2011).

The Facility and Layout

The current footprint of Hartsfield-Jackson International Airport is 4,800 acres. The terminal complex measures 130 acres, or 5.6 million square feet (HJIA, Sustainable Management Plan, 2011, p. 1-1). After the opening of a new international terminal in 2012, the airport now has two separate terminals where passengers are able to check-in and claim their bags. The Domestic Terminal, which is found on the west side of the facility, is divided up into Terminal North and Terminal South. The terminals are joined by a central atrium that contains various shops, restaurants, a chapel, offices, and conference rooms. Next to the Domestic Terminals are seven parallel concourses running towards the east – Concourses T, A, B, C, D and E, and F. Concourse T is connected to the Domestic Terminal. Terminals A – D are also used for domestic flights. Concourses E and F are used for international flights. All concourses are connected through an underground tunnel with walkways and the Plane Train, the airport's automated people mover. The Plane Train has a station at each concourse with a total of eight stops and travels around a 3.5-mile loop track. These trains operate at a frequency of approximately 2 minutes and the trains carry, on average, about 200,000 passengers a day (HJIA, Sustainable Management Plan, 2011, p. 1-1).

Figure 4: Layout of Atlanta's Airport



Source: http://www.visitingdc.com/airports/atlanta-airport-terminal-map.asp

Transportation

Built in 1968, Hartsfield-Jackson airport has its own station connecting to MARTA, Atlanta's rapid transit system. The station is located on the furthest right portion of the Domestic Terminal. MARTA's airport station stop is the furthest destination south for the transit system. Although limited in the scope of its connectivity, MARTA connects the airport to Fulton County, DeKalb County, and Cobb County through the Cobb Community Transit bus services. MARTA service is provided daily and trains leave the airport every four minutes (HJIA, Sustainable Management Plan, 2011, p. 1-6-5).

The airport has more than 30,000 public parking spaces, 13,500 of which are located in covered parking decks. Also, the airport also owns and operates the Rental Car Center (RCC), which is a 100-acre single point-of-service facility designed to co-located car rental companies serving Atlanta. The RCC is connected to the facility is provided through access roads and an automated people mover known as the SkyTrain (HJIA, Sustainable Management Plan, 2011, p. 1-1).

Assessment of Current Sustainable Initiatives

HJIA has several existing sustainable programs that address air quality, asbestos remediation, hazardous waste management, spill prevention and response, storage tank management, solid waste management, water quality management, wildlife management, and wetlands mitigation programs. Innovative measures were taken with the construction of the newly completed International Terminal. This 1.5 million square foot facility provides additional service access with 12 gates connecting to international destinations. The facility is LEED certified and has implemented a number of green features, including a 25,000 cubic foot water box, which collects rainwater from the roof and cleanses it before releasing the water back into the environment (HJIA, Sustainable Management Plan, 2011, p. 1-1-3).

In 2010, the Atlanta Airport developed its Strategic Plan. The Strategic Plan's key points are summarized in **Figure 5**. These points were identified as strategic priorities for the airport's future to contribute to HJIA's development as a leader in "efficiency" and "service excellence." (HJIA, Sustainable Management Plan, 2011).

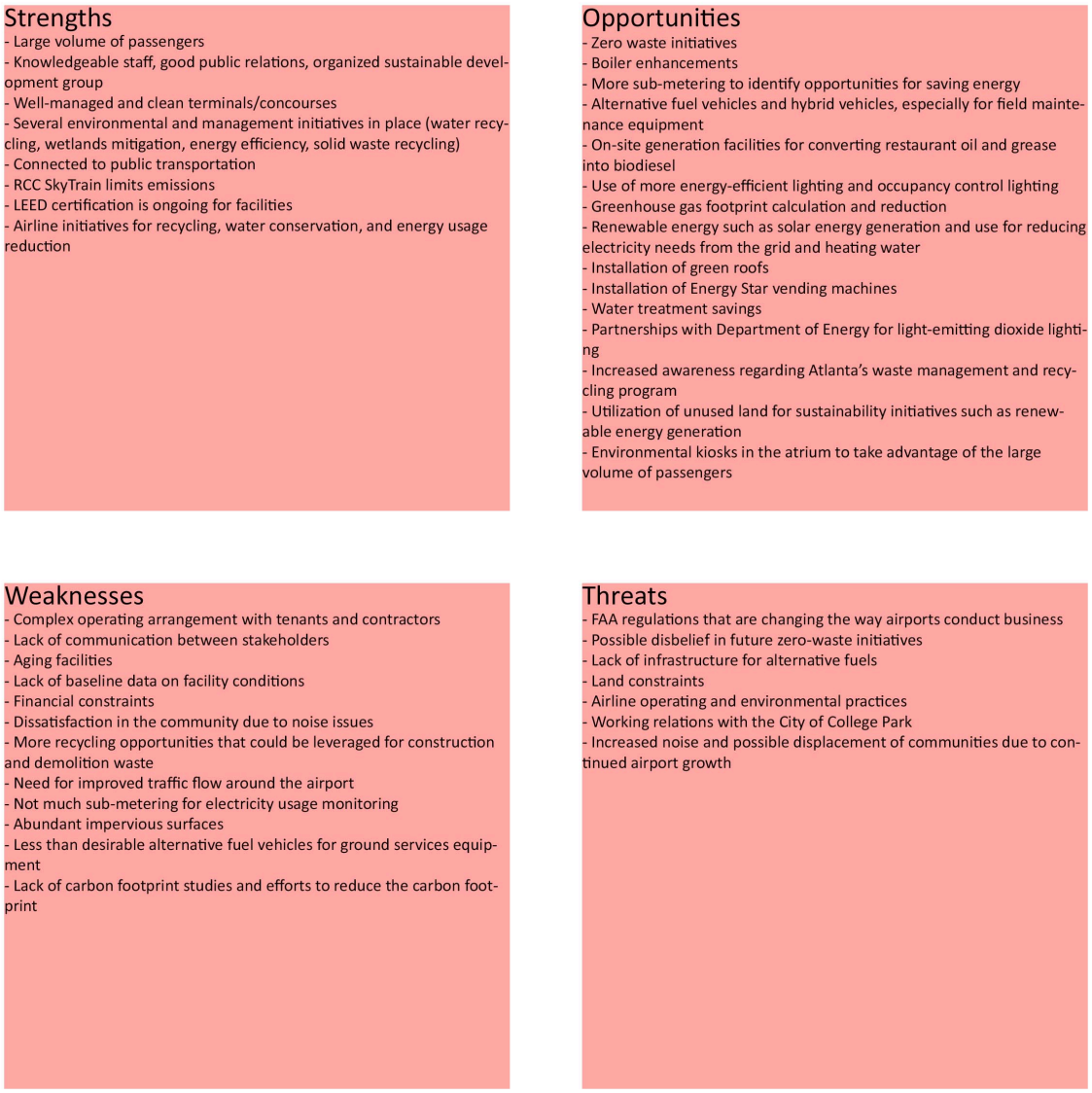
Figure 5: Atlanta Airport Strategic Plan

Source: Sustainable Management Plan, 2011

HJIA began the process of quantifying current initiatives and identifying future opportunities for sustainable practices in the 2011 Sustainable Management Plan. As part

of looking ahead, the intent of the report is to "seek to build partnerships with various public groups, work with stakeholders invested in the future of Atlanta, and enhance our focus on groups compatible with the surrounding community (HJIA, Sustainable Management Plan, 2011, p. 1-3). The Sustainable Management Plan provides project prioritization matrices and necessary steps to accomplish identified goals and opportunities.

Figure 6: SWOT Analysis for Atlanta's Airport



Source: Sustainable Management Plan, 2011; Compiled by author.

The Sustainable Management Plan additionally outlines a SWOT analysis for the Atlanta Airport. **Figure 6** identifies the strengths, weaknesses, opportunities, and threats for Hartsfield-Jackson International Airport.

Atlanta Airport's 2011 Sustainable Management Plan, or SMP, outlines proposed improvement opportunities and potential sustainable initiatives that could help these project come to life. The opportunities outlined in the SMP encompass the following categories:

- Enhancing sustainability of materials procurement and use
- Enhancing energy management and sustainability
- Enhancing water resource management and sustainability
- Opportunities to enhance emissions reduction and sustainability
- Enhancing waste reduction and improve sustainability
- Opportunities to enhance green construction and sustainability
- Opportunities to enhance community and stakeholder involvement

Appendix A lists the details of the various opportunities and initiatives for each category above. For Atlanta, emphasizing the surrounding community and the needs of the stakeholders is quite important for a sustainable future. HJIA has the potential to further develop itself as an economic hub. This is best achieved through cooperative collaboration with the surrounding community. There is no doubt that cost reductions and emission reductions are important factors, but HJIA also has the opportunity to generate a greater amount of jobs and to be surrounded by a thriving community.

Case Studies

Five case studies that exemplify innovations in sustainable airport practices where chosen to support recommendations for similar efforts at the Atlanta Airport. The airports chosen for case study comparison are: Boston Logan International Airport, Chicago O'Hare International Airport, Zurich Airport, Amsterdam Airport Schiphol, and Singapore Changi Airport. These examples were chosen because they represent a wide scope in sustainable innovation at the domestic and international scale. Each airport offers unique insight into innovative sustainable techniques. This section will explore specific efforts launched at each airport and will look into how the various projects and programs came into fruition.

CASE STUDY: BOSTON LOGAN INTERNATIONAL AIRPORT

Image 2: Aerial View of Boston Airport

Source: Google Maps, 2013, February)

In terms of sustainability, Boston's Logan Airport has been a leader in developing influential sustainable practices at airports. Boston was chosen as a case study because it implemented the innovative use of wind turbines within the airport facility. Additionally, the Logan Airport constructed the first LEED certified terminal. Sam Sleiman, the director of capital programs and environmental affairs at Logan International, states: "The perception is that airports are pollutants, and we wanted to change the perception" (Yu, 2008, September 16). As mentioned above, Boston's airport has contributed several projects in an effort to change this perception. Other current sustainable efforts underway at Boston's Airport are the use of ground power systems at gates, recycling, alternative fuel shuttles and taxis, water conservation, implementation of a light colored roof for sun reflection, energy-efficient lighting, and sustainable landscaping techniques. The airport also provides incentives for the use of alternative fuel vehicles through preferred hybrid

and alternative fuel vehicle parking. Also, 30% of all passenger and employee trips to Logan are High Occupancy Vehicles (Massachusetts Port Authority, 2010).

Massachusetts Port Authority, the operator of Logan International, has identified the following as incentives for why they should care about sustainable airport development (Dalzell, 2009):

- Progress in reducing airport and aviation impacts is key to sustainable aviation industry growth
- Demonstrated commitment to reducing impacts is essential to growing and upgrading our facilities
- Efficiencies benefit the environment and can produce savings for the airport, tenants, and airlines

The airport's mission shows that they have acknowledged certain limitations to airport growth. To overcome these limitations, the airport strives to minimize its carbon footprint while still promoting development and facility expansion. The Massachusetts Port Authority brings the added benefit of regional transportation planning perspectives, for the agency operates all three airports within the region, the seaport facilities, and connecting transit services.

Logan's Wind Turbines

In addition to evaluating solar power, geothermal technology, and fuel cell applications, Boston's Logan Airport has researched and implemented the use of energy supplied through wind turbines (Massachusetts Port Authority, 2010). This particular project proves to be quite unique and innovative. In March of 2008, Logan International installed 20 6-feet tall and 8-feet wide wind turbines on the roof of the airport's main office building to take advantage of the region's windy conditions (Yu, 2008, June 30). The wind turbines are providing clean, reliable, and non-polluting electric power. The expected energy savings was 100,000 KWH annually, which is approximately two percent of the airport's total energy use. The facility's average monthly power consumption is estimated at 291,000 KWH. The turbines each cost about $140,000 and should provide annual savings in utility costs of about $13,000. Research and cooperation with private organizations were main contributors in successful project implementation. The wind turbine project was the result of collaboration between the Massachusetts Port Authority, AeroVironment, and Groom Energy Solutions (Center for Community Progress and City Parks Association, 2013).

Image 3: Wind Turbines at Logan Airport

Source: Hilton, J. (2008). The New York Times. Retrieved from: http://www.nytimes.com/2008/09/04/business/04wind.html?pagewanted=all&_r=0

Logan's LEED Certified Terminal

Logan Airport's Terminal A was the first airport terminal to achieve LEED certification from the U.S. Green Building Council when it opened in March of 2005. This project reflected the "intent of Delta Air Lines, based in Atlanta, and the port authority to meet the LEED requirements for certification by applying the principles of sustainable design to energy use, lighting, material use, and other facets of construction" (Massachusetts Port Authority, 2006, p. 32). The terminal's design included the following improvements: installation of special glass that reflects heat from the windows to minimize heat loss during the winter and heat gain during the summer, participation in the port authority recycling program, and the use of special storm-water filtration devices that lower the levels of suspended solids and phosphorus in the site's runoff. (Massachusetts Port Authority, 2006). The LEED certified terminal exemplifies Logan Airport's commitment to sustainable design and construction.

The Massachusetts Port Authority, or more simply known as Massport, recognizes that there are barriers to implementing LEED in airport terminals. They have published these

barriers in the hopes that other airports may learn and devise implementation strategies to overcome the outlined difficulties. The barriers include the following (Dalzell, 2009):

- Real and perceived soft costs versus construction cost impacts
- Relationship of who bears costs versus who reaps benefits
- Capital markets did not yet fully recognize value of initiative
- No explicit regulatory benefits or requirements

Massport also acknowledged certain lessons that were learned during the implementation process. For example, there is a necessity to set goals early and to develop a full commitment to LEED principles. Also, to speed along the process and help projects come into fruition, the authority recommends the utilization of government incentives for investments into energy efficiency (Dalzell, 2009).

CASE STUDY: CHICAGO O'HARE INTERNATIONAL AIRPORT

Image 4: Aerial View of O'Hare Airport

Source: Google Maps, February 2013

Chicago provides an interesting case study scenario in that it is the second busiest airport in the Unites States. Like the Atlanta Airport, Chicago O'Hare has been ranked consistently among the top busiest airports in terms of passenger traffic. The airport had 66,561,023 passengers in 2011 – making it the fourth busiest airport in the World. O'Hare currently generates 540,000 regional jobs (which include 28,000 airport employees) and $45 billion dollars in economic activity for the State of Illinois (Chicago Department of Aviation, 2012).

Sustainable Airport Manual

Chicago's O'Hare Airport has situated itself as a leader in sustainable airport planning and practice. This is especially evident through the City of Chicago Department of Aviation's publication entitled the Sustainable Airport Manual, or SAM. This manual is dedicated to providing the best sustainable practices and to enhancing the quality of life within the

metropolitan region. Also, this document, which was first released in 2009, was the first of its kind in providing sustainable guidance for airport planning (Chicago Department of Aviation, 2011). The SAM intends to serve as a template to improve sustainable practices at any airport, not just Chicago's. The manual includes a scoring system for design, construction, operations and maintenance, and tenants.

In August of 2003, Illinois Governor Rod Blagojevich signed the O'Hare Modernization Act. The program was established to ensure airport efficiency due to the economy's heavy dependency on the success of these operations. This basis of this legislation is that efficient practices at O'Hare Airport are quite important in that the airport enhances the overall economic welfare of the state through job creation and business attraction (Chicago Department of Aviation, 2013). The project is funded through Passenger Facility Charges, General Airport Revenue Bonds, and Airport Improvement Program Funds. Overall, the projects that have stemmed from this legislation have resulted in annual savings of $370 million for airlines and $380 million for passengers. This program has created 195,000 additional jobs and $18 billion in economic activity (Chicago Department of Aviation, 2013).

Green Roof Installations

Innovative sustainable projects at Chicago's Airports are primarily exemplified through the green roof installations at both O'Hare and Midway International Airports. Chicago's Department of Aviation remarks that the idea for green roofs came from the department's desire to lead by example through a visible environmental commitment (Peters, 2011). The main goal is to reduce storm water runoff. The airport installs green roofs wherever possible to reduce the urban heat island effect, conserve energy, and reduce storm water. The Chicago Department of Aviation states that there are several considerations when implementing green roof technology at the airport (Peters, 2011). These include concerns over plants attracting wildlife, foreign object debris, and plant maintenance. Also, probably the most important consideration is that the installation and maintenance of green roofs must outweigh the costs (Peters, 2011).

Chicago's Department of Aviation used several measures to combat the potentially negative implications of green roofs. To ensure that wildlife would not be attracted to the vegetation (thereby posing a threat to aviation activity) specific plants were chosen. These plants tolerate drought, do no produce berries or seeds, and do not attract wildlife habitation. Research on which plants would best fit these needs was conducted through a partnership with the University of Illinois. As of 2011, there were 229,355 square feet (5.26 acres) of vegetated roofs installed at Chicago's O'Hare airport. An additional 108,816 square feet

(2.50 acres) are planned for the United Airlines Cargo Building. The first vegetated roof was completed in 2006. This was the first on-airport FAA facility in the nation to integrate green roof technology (Peters, 2011).

The vegetated roof on the FedEx Main Sort Building contributes 174,442 square feet of O'Hare's total green roof coverage. For this particular project, vegetation for the green roof cost $14.53 per square foot (total vegetation costs is $2,534,642). The structure on the roof needed to support the vegetation cost $1,815,941, or $10.41 per square foot. The total cost for this particular project was $4,350,583, or $24.94 per square foot. Energy savings for the green roof construction are estimated at a savings of $0.20 per square foot per year in energy costs. Although the actual cost savings are not overwhelmingly large, a green roof contributes many other benefits. These include: improved long-term roof performance, reduced air emission impacts, improved interior noise levels and air quality, non-reflecting roof to reduce heat island effect, reduction in storm water flow, a visible commitment to improving the environment and thereby improving public image (Peters, 2011).
To complete the process of installing green roofs, the Chicago Department of Aviation lists several lessons that may be learned. First, there is a need for buy-in from key stakeholders. Next, there needs to be facilitation of education involving all concerned parties. Also important, the goals need to be clearly defined and communicated (Peters, 2011).

Additional Sustainable Practices

Examples of other innovative sustainability programs and initiatives at O'Hare Airport include the following (Chicago Department of Aviation, 2012):

- Replaced 150 acres of wetlands with 450 acres in mitigation process
- First Airports Going Green Conference (2009)
- Airport Apiary and Aeroponic Garden installed (2011)
- Bike to work Plan: airport employees are encouraged to bike to work year-round. The program provides employee bike storage, employee bike racks, and availability of lockers and showers.
- Installed Green-themed kiosks throughout the terminal to encourage everyone to work together to conserve and protect the environment and improve quality of life. The kiosks educate travellers on green initiatives and provide information on what they can do.
- Sustainability-themed displays / educational "Earth Day" program
- Installations to promote awareness of local, homegrown food

The airport has implemented many other sustainable initiatives. However, the list above provides insight into the most innovative practices. A unique feature of the outlined goals in City of Chicago's 2015 Sustainable Chicago Action Agenda is that they are aiming at improving the passenger's travel experience at the city's airports (Chicago Department of Aviation, 2012). These efforts are recognized through the following acknowledgement:

> "Access to daylight and the outdoors are becoming common themes in airports as we become more aware of the positive health and well-being effects on our passengers and employees by providing access to nature … The incorporation of daylight, outdoor areas, healthy food options, exercise facilities, spa-like concessions, movie theatres, and even golf courses are becoming more prevalent" (Chicago Department of Aviation, 2012, p. 44).

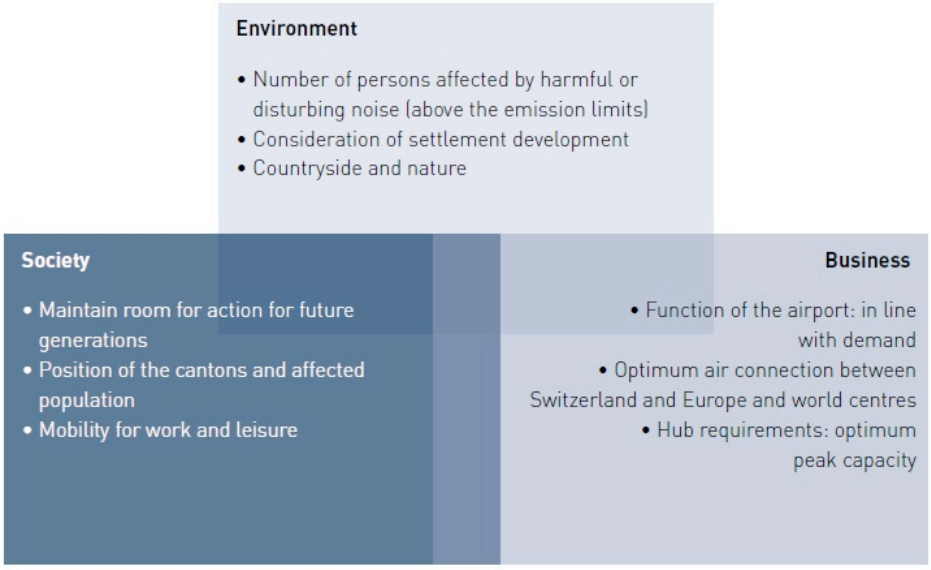
Chicago's Department of Aviation believes these improvements will enhance the passenger's experiences and potentially create new jobs and revenue streams (Chicago Department of Aviation, 2012). Additionally, the Chicago Department of Aviation believes that providing detailed information on sustainable efforts will improve relations with stakeholders and the community (Chicago Department of Aviation, 2012). CDA began publishing an annual sustainability report in 2011.

CASE STUDY: ZURICH AIRPORT

The original structure of the Zurich Airport opened in 1948. The facility has since undergone several expansions and renovations, which were completed in 1961, 1971, and 1976. The airport was privatized in April 2000, yet the Canton of Zurich still holds more than 50% of the airport's shares. A major expansion of the airport began in 2003. This project included a new parking garage, a new midfield terminal, and automated underground passenger train. Another renovation project began in 2008. The airport facility spans over 880 hectares (2,175 acres or about 3.4 square miles) and serves as "an impressive feature in the landscape of the region" (Flughafen Zürich AG, 2008, p. 22).

The passenger count for Zurich Airport was 24,337,954 in 2011 (Flughafen Zürich AG, 2011). This means that Atlanta has almost four times as many passengers per year. Although they are not comparable in size, the Zurich Airport is innovative in its sustainable design practices and provides valuable examples for promoting the preservation of natural landscapes. The airports in Atlanta and Zurich are similar in their distance to the central business districts: Zurich Airport is approximately eight miles north of the city center, which is comparable to Atlanta Airport's seven miles south of the central business district. The Zurich Airport offers an example of one of the best ground transportation systems that is linked to an airport node. The Zurich Airport was chosen as a case study for its exemplary transportation system and for its innovative techniques of integrating dedicated nature conservancy zones within its facility boundaries and in the greater airport area.

Figure 7: Sustainable Development at Zurich Airport



Source: Flughafen Zürich AG (2008)

Figure 7 above outlines Zurich Airport's sustainable policies. Particularly unique is their emphasis on maintenance of the countryside and preservation of nature. In regards to their sustainable practices, the Zurich Airport defines their methodology as:

> "A multi-dimensional and interlinked approach is necessary for the long-term success for an enterprise. In strategy and implementation, the three dimensions of economy, environment, and society must always be part of the decision-making processes" (Flughafen Zürich AG, 2008).

The multi-dimensionality comes from the involvement of stakeholders and any interested parties within the community. While considering the viewpoints of society, business, and the environment, the airport also maintains open dialogue with its stakeholders to ensure sustainable development.

Environmental Sustainability

The Zurich Airport is making great strides in the direction of environmental responsibility. According to the Zurich Airport's 2011 Annual Report, "The [airport] follows a range of regulatory, technical, operational and commercial measures to operate the airport in an environmentally efficient manner" (Flughafen Zürich AG, 2011).

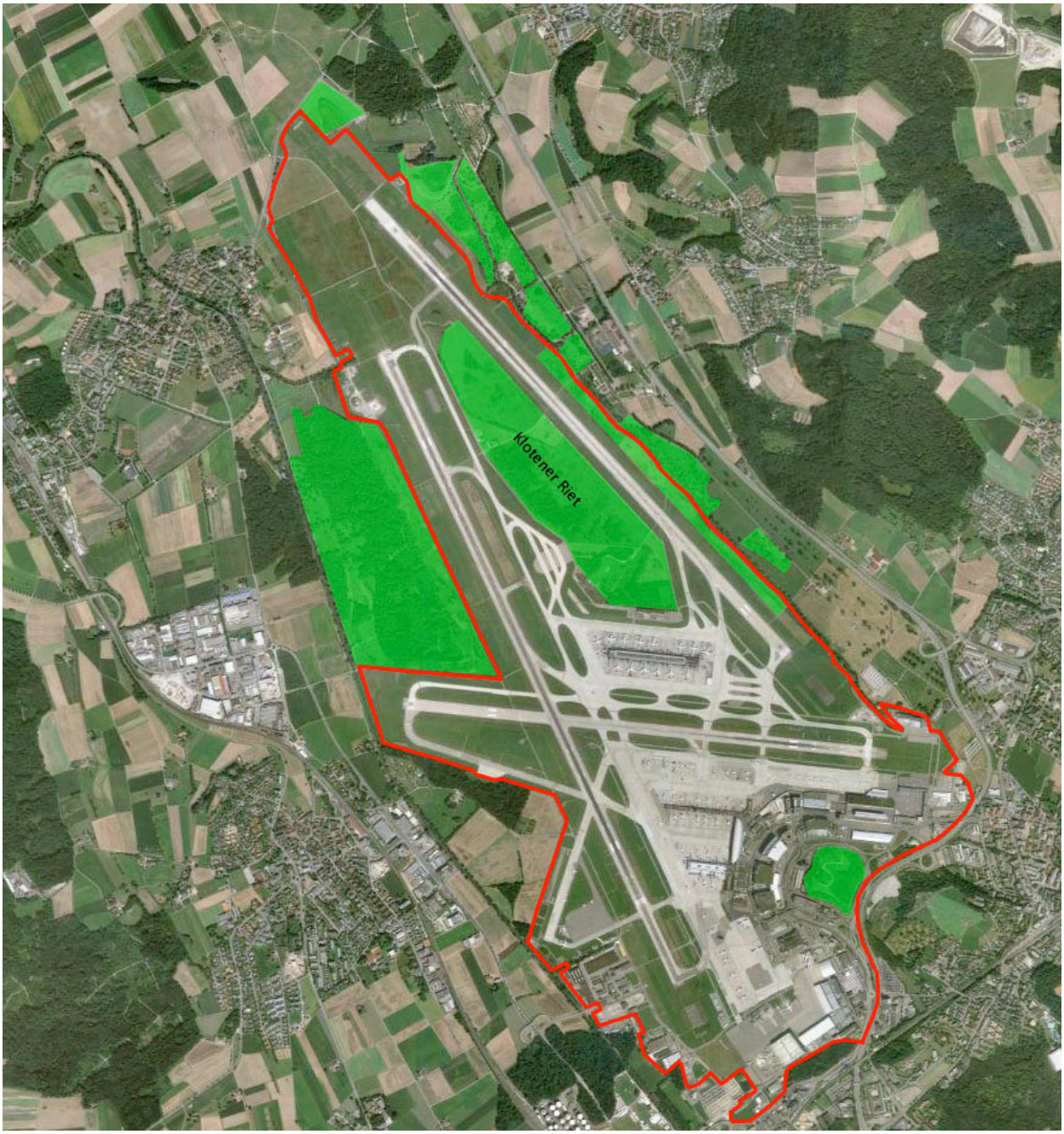
In regards to environmental sustainability, the airport continually strives to balance growing commercial and social demands with environmental protection. The following list sums up the most innovative criteria in which the airport has focused its environmental sustainability efforts (Flughafen Zürich AG, 2008):

- Help all employees become aware of environmental issues so they can integrate them actively into their daily work
- Yearly environmental significance assessment
- Large consumer agreement: calls for an increase in overall energy efficiency by 2 percent each year until 2014 for all of the buildings in and around the airport
- Nature conservancy zones
- Charges for airlines and passenger noise fees which are used to finance noise protection measures as well as compensation payments to settle lowered property values resulting from excessive aircraft noise impacts
- The airport offers a noise call-center and email system through which people are guaranteed to receive a reply

Nature Conservancy Zones

A unique feature of the Zurich Airport is the natural conservation area known as "Klotener Riet." According to the Airport's sustainability report, "more than half of [the airport's] area is not developed and is not used directly for aviation purposes. These green zones include nature preserves and various meadows"(Flughafen Zürich AG, 2008, p. 38). The 74 hectare (or about 183 acres) Klotener Riet is located between two runways and includes 24 hectares (or about 60 acres) of low moorland. The Airport, in cooperation with the Cantonal Nature Conservation Agency, is required to maintain the nature conservation value of these areas (Flughafen Zürich AG, 2008).

Figure 8: Zurich Airport Area



Source: Flughafen Zürich AG, 2010; Google Maps, February, 2013; Graphic compiled by author.

In **Figure 8**, the green areas indicate the locations of the nature conservation zones found around the Zurich Airport. Additionally, the airport's boundary is outlined in red. **Figure 8** labels the Klotener Riet, which is located between two runways.

Another innovative mechanism applied during a 2001 Zurich Airport expansion was to offset affected nature conservation areas with the establishment of a new 5-hectare (12

acres) biotope in an area north of the airport. Additionally, "nature conservation areas were also set up along the river Glatt near Rümlang and in the municipalities of Steinmaur and Weiach to offset the environmental impact" (Flughafen Zürich AG, 2010). The Zurich Airport lists the following as positive impacts of their nature-oriented approach (Flughafen Zürich AG, 2010):

- Lower bird strike risk through greenery management that makes it difficult for birds of prey to hunt for food
- Promotes development of cohesive meadow landscape

Transportation Infrastructure

An important feature of the Zurich Airport is its efficient link to local transportation infrastructure. There is a train station located underneath the airport terminal that provides connections to many parts of Switzerland. Zurich Airport "supports and promotes the improvement of public transportation together with its partners" (Flughafen Zürich AG, 2008, p. 24). Benefits of these efforts are revealed through a 2003 survey, which revealed "43 percent of all trips to the airport were done with public transportation" (Flughafen Zürich AG, 2008, p. 24). The Airport continues to promote the usage of public transportation and is focusing its efforts on maintenance to ensure that the airport remains a major transportation hub in the long-term. Additional innovations related to the airport's transportation network include (Güller and Güller, 2001):

- Fly Rail, which allows passengers to check their luggage through to the railway station of their choice in Switzerland
- Construction of dedicated bus and tram lanes (Glattal Tramway)
- Privately funded extended bus service to connect nearby airport partner companies to commuter rail (S-Bahn)

Zurich: Airport Corridor

Zurich Airport provides an example of airport-centric development, and specifically exemplifies an "airport corridor." In this type of development, the airport corridor "links airport and central city as a band of integrated road/rail infrastructure and property development" that "seeks to transform this space into an integrated economic zone" (Freestone and Baker, 2011, p. 268). This coordination in commercial development and

infrastructure requires collaborative efforts from both private developers and public infrastructure authorities (Freestone and Baker, 2011). This airport corridor development emphasizes that there is a need to think regionally, versus only in the airport area context. The airport serves and supports the regional economy; therefore, a regional perspective is necessary to coordinate efforts from public and private organizations and authorities. These efforts are exemplified by Zurich Airport as the airport area and the airport development corridor and surrounding redevelopment area are included in the spatial development plan for the Canton of Zurich (Güller and Güller, 2001).

Zurich's integrated transportation network is one of the main facilitators of this airport-centric development trend. This is noted by the statement: "One of the most renowned assets of Zurich Airport is its high accessibility by public transport, enhanced by the fact that it is also strongly used as an interchange for regional networks" (Güller and Güller, 2001, p. 99). To complete the integrated transportation network, a light-rail and an extended tramway line increase and improve connectivity. The airport provides a central location for international marketplaces to convene and allows for enhanced connections between foreign business centers. The efficient transportation network "takes a key part in the added-value chain which includes various suppliers and thus triggers further income and jobs – primarily in the airport's surrounding region" (Flughafen Zürich AG, 2008, p. 20). Through looking at Zurich Airport as a case study, it appears that investment in transportation infrastructure is a main driver in airport-centric development. Businesses will locate at airports if these areas provide benefits like enhanced connectivity and accessibility through transportation.

The Zurich Airport functions quite differently from most United States airports. Due to the airport's privatization, there is an increased need in communication between government and the airport. This is facilitated with roundtable meetings and airport forums that are coordinated at the political level (Flughafen Zürich AG, 2008).

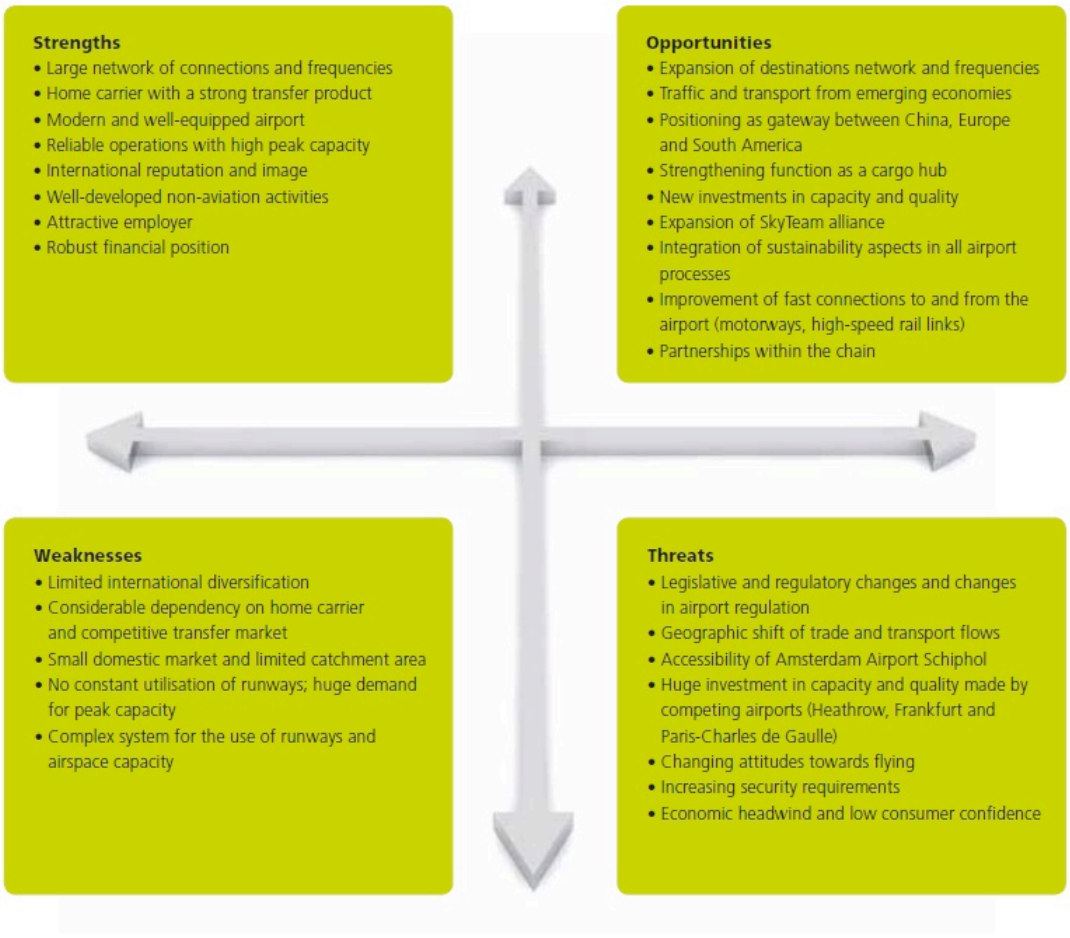
CASE STUDY: AMSTERDAM AIRPORT SCHIPHOL

Figure 9: Schiphol Airport in relation to Zuidas and Amsterdam

Source: Google Maps, February 2013

Amsterdam's Schiphol Airport is an important travel and business hub. In 2012, the airport had 51,035,590 total passengers, which is a little more than half of Atlanta's passenger count for 2012 (95,462,867). This airport was chosen as a case study because it has proved exemplary in attracting businesses to the airport vicinity. These businesses cluster at the Zuidas development, which is approximately 6 miles east of Schiphol Airport. Amsterdam's Airport Schiphol and adjacent Zuidas provide an excellent example of an Airport City.

Figure 10: SWOT Analysis for Amsterdam Airport Schiphol



Source: Schiphol Group, 2011

Figure 10 summarizes Schiphol's strengths, weaknesses, opportunities, and threats. Like the Atlanta Airport with Delta Air Lines, Schiphol Airport is considerably dependent on its home carrier, KLM. Schiphol has identified a threat in the investment projects underway at several other large European airports. This threat additionally pertains to the Atlanta Airport. However, unlike HJIA, Schiphol has a modern, well-equipped airport, developed non-aviation industries in surrounding areas, and an overall positive reputation within international business perspectives. Schiphol's investment in educational partnerships, enhanced transportation accessibility, and involvement of stakeholders contribute to these strengths in airport development.

Educational Partnerships

Amsterdam's Schiphol airport strives to be a leader in technological innovations. To achieve this goal, they have "partnered with Delft University of Technology, Wageningen University, Imtech and the Netherlands Organisation for Applied Scientific Research in 2010 to establish the innovation platform theGROUNDS" (Schiphol Group, 2011, p. 16). This organization comprises initiatives to form partnerships between businesses and higher education institutions to promote innovative sustainable airport applications (theGrounds, 2013). The specific goals of this organization are to research techniques in sustainable water, energy, and air quality.

Schiphol Airport also takes pride in its work force. They strive to attract personnel who bring "talent, diversity, succession planning and an active position within the labor market" (Schiphol Group, 2011, p. 17). Additionally, the airport has implemented a program entitled Schiphol Traineeship, which hopes to train the next generation of flexible and change-oriented managers. Other innovative programs include (Schiphol Group 2011):

- Schiphol Fund: airport provides grants to non-profit institutions within the community that work towards the advancement of welfare, culture, or sports
- Schiphol College: network organization that forges links between businesses, education, and the job market to create more employment opportunities within the aviation branch by providing work experience, training programs, etc.
- Charity Partnerships: every three years new partnership with international charity focusing on children's needs

Transportation and Accessibility

Schiphol's 2011 Annual Report states "accessibility is the most important factor in passengers' choice of airport. It is also a crucial factor for companies, suppliers and employees" (Schiphol Group, 2011, p. 16). The airport functions successfully not through its own efforts, but relies on a network of organizations to improve accessibility and mobility. The airport works with ProRail and Dutch Railways to ensure that the airport is linked to important rail connections.

Stakeholder Engagement

Schiphol Airport also has a tradition of working with its surrounding communities. Significant air traffic growth in the 1980s caused the Dutch government to limit the number of air traffic movements as a condition for airport expansion in 1995. Legislation was reversed in 1997, and new criteria to limit growth are based on noise, emissions, and safety. This caused Schiphol airport to adopt an innovative approach to mitigate the

negative criteria so that airport growth would not be hindered. This approach was successful, but studies revealed that predicted airport growth would produce too much noise pollution by 2008. To make further growth of the airport possible while maintaining livability of surrounding neighborhoods, the government formed a special group of stakeholders that represented the airport and the communities. The group negotiated an agreement that was later adopted as national policy and could accommodate further growth in air traffic movements (Boons et al., 2010, p. 307). Additionally, North Holland, the municipalities of Amsterdam and Harlemmermeer, and Schiphol airport are tied together in planning and development coalitions.

Amsterdam Airport and Zuidas

Amsterdam's Airport is renowned for Zuidas, its aviation-related business district. Zuidas, an example of an airport city, is defined as "more or less dense cluster of operational, airport-related activities, plus other commercial business concerns, on and around the airport platform" (Freestone 268). Basically, the airport provides a platform for which these businesses may ship their goods and services with enhances speed and efficiency.

The developments concentrated around Zuidas "include business office complexes, hotels, meeting and entertainment facilities, logistics parks, shopping and other commercial activities" (Kasarda 2007 10). According to Kasarda, "over 60,000 people are employed at Schiphol, which integrates multi-modal transportation, regional corporate headquarters, retail shopping, logistics and exhibition space to form a major economic growth pole for the Dutch economy" (Kasarda, 2007, p. 10). Zuidas is often cited as a positive example of airport-centric business development. The area has attracted more than 1,000 multi-national firms. It serves as a new city center for the greater Amsterdam region that offers a unique urban experience (Jantzen and Vetner, 2008). Zuidas city center offers enhanced access to the airport and surrounding areas, attractiveness for international businesses, and provides world-class shopping facilities (Jantzen and Vetner, 2008). The positive economic development impacts seen in Zuidas support the argument that airport-centric development is good for business.

Zuidas development was spurred through desire of the Amsterdam region to compete with other global commercial centers. The aging infrastructure of Amsterdam's central business district did not provide the ideal amenities that assist in attracting international business (Jantzen and Vetner, 2008). Overall, Zuidas has experienced positive results in economic and job growth within the vicinity of the development.

Zuidas is the result of public-private land partnerships. The development was spurred by the bank ABN AMRO's decision to establish its new headquarters in close proximity to the Amsterdam Zuid Station and Schiphol Airport. Following the bank's arrival, Amsterdam developed a master plan for the Zuidas area in 1998 that strove to create a place that balances living, working, and amenities. This plan is updated every year, which helps to ensure successful development through time (Zuidas Amsterdam, 2013).

CASE STUDY: SINGAPORE CHANGI AIRPORT

Image 5: Aerial View of Changi Airport

Source: Google Maps, February 2013

Singapore's Changi Airport is a main contributor to Singapore's overall economy (Changi Airport Group). There are more than 28,000 people employed at the airport. In 2012, passenger traffic reached 51,200,000 (46,500,000 million in 2011). The airport has significant growth potential in that there is capacity for up to 66,000,000 passengers. Similar to Atlanta's Airport, Changi is located 10.7 miles outside the central business district (compared to Atlanta at 7 miles). The facility is operated by the private Changi Airport Group and is located on a 5 square mile site. Like the Atlanta Airport, Changi has

limited land resources. The airport infrastructure was designed to meet current and future needs. There are currently three passenger terminals that are connected with a monorail people mover system.

Changi Airport is chosen as a case study because it exemplifies forward-thinking efforts in Asia, where heavy investment in airport infrastructure is a growing trend. Kasarda states: "Aviation is the 21st century physical Internet" because it offers "speedy, long-distance physical connectivity using airports as its routers… Asian nations recognize this and are investing heavily in their airports and aerotropolises as competitive tools for 21st century global commerce and trade" (Kasarda, 2011, p. 19). In order to keep up with the Asian business markets, HJIA planning efforts could perhaps incorporate some of the innovative techniques employed at Changi. Also, Changi Airport was chosen as a case study because it is consistently ranked among the top three airports in the world (Skytrax).

Additionally, Changi Airport provides example of what an airport should not do. The airport "has demonstrated a low concern regarding the reporting on sustainability themes, mainly on the environmental and social" side (Jordão, 2009, p. 32). However, this does not signify that "the airport is not performing well on these environmental and social performance indicators. Instead it transmits a lack of transparency for the stakeholders once the information related to all these important themes is currently not publicly available" (Jordão, 2009, p. 32). The Changi Airport's website offers limited information in report format that assesses its sustainable efforts. However, Changi Airport Group's website has identified five focus areas in environmental sustainability. These include: emissions, energy efficiency, waste management, noise management, and water management.

Figure 11: Layout of Singapore Changi Airport

Source: http://www.ifly.com/singapore-changi-airport/terminal-map

Innovative Terminal Amenities

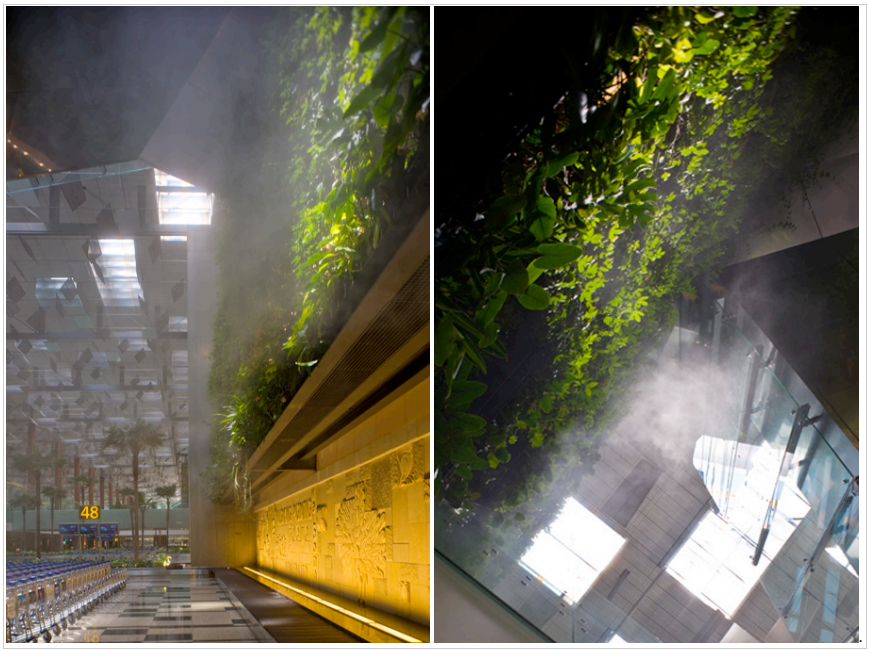
The layout of Changi Airport is seen in **Figure 11** above. Terminal 1 was completed in 1981, Terminal 2 was completed in 1989, and Terminal 3 was completed in 2008. Terminal 3 incorporates many innovative sustainable design features. The design utilizes transparency and incorporates natural features throughout the terminal. The roof has 919 skylights that allow natural light to enter the building. Additionally, a 16 high green wall provides a tropical atmosphere to the terminal space and helps regulate internal temperature. The wall consists of 10,000 tropical plants and spans five stories in height. The goal of incorporating these innovative designs was "to make the landscape features the defining elements of the terminal, rather than mere decorations (ARCPROSPECT, 2013). The image below shows a rendering of the innovative terminal design of Changi's Terminal 3.

Image 6: Interior view of Changi International Airport

Source: ARCPROSPECT, 2013

Image 6 above shows a view of the "green tapestry" wall found in Terminal 3. The feature measures 46 feet in height and 980 feet in length and was incorporated to soften the structural proportions. The easily maintained green wall incorporate consists of over 10,000 plants and introduces warmth and softness to the surrounding stone, glass, and steel structures. (ARCPROSPECT, 2013). The project cost is undisclosed. **Image 7** and **Image 8** below provides an additional view of the green wall feature found in Terminal 3.

Image 7 and Image 8: Views of the Green Wall Installation



Source: ARCPROSPECT, 2013

Changi airport has extensive offerings that include shopping and restaurants found in over 753,500 square feet of space. According to John Kasarda, "Airport terminals are fast becoming luxurious shopping malls and artistic and recreational venues. No longer restricted to magazine shops fast food outlets, and duty free, they now feature brand name boutiques, specialty retail, and upscale restaurants along with entertainment and cultural attractions" (Kasarda, 2007, p. 2). Changi is a leader in this movement as it offers a variety of lounges, amenities, and even boasts a nature trail, gardens, butterfly forest, and other entertainment options.

As mentioned earlier, Changi is consistently ranked as one of the world's best airports. SKYTRAX chairman Edward Plaisted suggests reasoning as to why: "The well thought out and quite unique leisure facilities including a swimming pool, open garden and cinema continue to be a driving force behind Changi Airport success as the world's leading transfer airport" (Skytrax). To ensure that Atlanta's Airport passengers have pleasant experiences, they should learn from the precedent set by Changi. Yet, the goal is not for Atlanta to copy the fancy terminal enhancements implemented at Changi Airport. Changi simply provides insight in the types of improvements that may be valued the most by passengers.
The following lists additional amenities offered at Changi's airport (McCartney, 2011):

- Comfortable areas for sleeping and watching television
- Premium bars

- Work desk space and free internet
- Nap rooms for approximately $23 for 3 hours
- Showers are available for $6
- Pool access for $11 per person
- Free bus tour of Singapore
- Amusement park and four-story slide
- Errand and shopping amenities: dry cleaners, pharmacy, flower shop, jewelry stores, clothing stores

Efforts at Changi Airport bring about an interesting argument on whether these luxury amenities matter. Do passengers really prefer one airport over another based on the entertainment, recreation, and relaxation features that an airport offers? Changi Airport believes passengers do choose airports based on these features (McCartney, 2011). Changi uses these perks "to entice passengers to spend more money at the airport and select Singapore over other connecting hubs" (McCartney, 2011). As competing hub airports emerge in this global economy, there may be an increase in the extravagant amenities or an enhancement in convenient and comfort amenities found at airports. Passenger well-being is cited as an aspect of a socially sustainable airport, and Changi serves as a leader in providing amenities that are aimed at pleasing passengers. The airport facility not only serves as a transportation node for air travel, but serves as a community hotspot where people gather, shop, and enjoy leisure activities.

Efficient Transportation Network

Part of an economy's success is based on the efficiency of a region's transportation systems. As the famous architect and urban planner Le Corbusier stated, "the city which can achieve speed will achieve success" (Freestone and Baker, 2011, p. 265). A city achieves this speed through an accessible transportation network. Changi Airport, like the airports in Amsterdam and Zurich, has an extensive transportation network that successfully links the airport to the surrounding communities. Changi Airport offers mass transit connectivity and accessibility through airport shuttles, buses, and trains. The free shuttle bus service connects people to businesses by providing service to the nearby Business Park. Changi airport is also connected to the city center with an expressway. The airport's connection to Singapore's Mass Rapid Transit network is located underneath Terminals 2 and 3. Additionally, buses and taxis provide service to the airport connecting people to their destinations.

CONCLUSIONS AND RECOMMENDATIONS

The bottom line for sustainable airport planning efforts is often financial. Unless otherwise forced through political barriers, for an airport to implement an environmentally friendly project, the project needs to make financial and economic sense. Financing appears to be the most frequently cited barrier in sustainable airport planning efforts. However, as sustainable airport planning efforts move towards a more holistic approach that encompasses economic, social, and environmental characteristics, more innovative initiatives and programs are emerging. Socially sustainable practices are increasingly becoming quite important. As was mentioned above, there are certain criteria and amenities that passengers prefer in airport facilities. Also, people are becoming more aware of negative environmental impacts, especially in relation to global warming and the urban heat island effect. There has even been a recent trend in polling public opinion that protecting the environment is valued as increasingly more important that economic growth (Carlson, 2005). The public mind and viewpoints will no doubt be important factors in this new age of airport planning and overall airport area development. Through the discussion and review above, a greater sense of airport sustainability, especially in a global context, is reviewed. The next steps are to provide a framework for which this data becomes useful for the Atlanta context. The concluding recommendations will review the following:

- Lessons learned from cases studies
- Financial barriers and opportunities
- Improving, maintaining, and expanding corporate partnerships
- Focus on airport area and economic development
- Airport-area industry growth in congruence with needs
- Privatization and potential applicability to the Atlanta Airport
- Transit expansion and opportunities
- Growth of airport offerings
- Develop branding and identify of airport area
- Reporting initiatives
- Education and Partnerships with Universities
- Keeping up globally

Case Study Review

The case studies analyzed in this research project brought forth interesting ideas and projects in sustainable airport development. The wind turbines used at Boston's Logan Airport provide an excellent example of using innovative technological techniques to reduce energy consumption. It also provides an example of how private-public partnerships assist in project implementation. However, for the Atlanta context, wind turbines would not be the best viable option. Logan Airport benefits geographically from the regions windy conditions. For Atlanta, solar panels may provide a more practical approach to reducing energy costs. Additionally, they are mentioned as an opportunity for renewable energy sources in the Sustainable Management Plan. Atlanta could perhaps partner with a company that specializes in solar panel research and production. The airport provides an ideal environment for such a business to advertize their products to a wide audience due to heavy airport traffic.

Chicago's O'Hare Airport provides the spirit of innovative leadership in sustainable design. The Sustainable Airport Manual provides information on best practices that can be applicable to any airport. Atlanta could follow in these innovative footsteps and develop additional sustainable monitoring and measuring schemes. Also, the discussion on green roof design and implementation could be quite applicable to the Atlanta Airport context. Again, financial backing through a private source could initiate the planning for green roof implementation at HJIA.

Zurich Airport provides exemplary examples of emphasizing green developments. Although the greater Atlanta Airport area is already largely developed, there may be opportunities to sanction greenspaces within the greater airport region that could be implemented to offset carbon emissions. In addition, a park could be created adjacent to the airport that allows people to view planes as they arrive and depart. HJIA does have several tracts of available land that may serve as ideal spaces for such a park. An airplane observation park may contribute to a niche in tourism and may enhance the attractiveness of the airport area. Even if these developments do not have significant beneficial impacts for the environment, they may generate increased interest and desire to incorporate green measures throughout the community. In an effort to promote greenspace, the airport could implement a regional development scheme in which they purchase land within the metropolitan region to designate as a conservancy zone in exchange for airport facility construction and expansion.

Amsterdam Airport and Zuidas provide an excellent example of attracting business to an airport-centric location. The success of Zuidas in terms of business development signifies the success of private-public partnership in aviation-centric development. The future

opening of the new Porsche headquarters adjacent to the Atlanta airport (like what happened with the bank headquarters at Zuidas) may serve as the private interest investment that is necessary to promote airport-centric growth. Additionally, the Schiphol airport and its surrounding area development planning are approached through a regional perspective. However, an important lesson from Zuidas is that airport-centric development is dependent on efficient and accessible transportation networks. Most of the case studies considered seem to thrive on well-connected transportation systems.

Changi Airport provides excellent examples of innovative measures that are geared towards pleasing passengers and creating an enhanced travel experience. In terms of a global point of view, the Unites States and other Western countries are starting to view Asia as a competing economic powerhouse. HJIA does not have the existing infrastructure to incorporate grand entertainment features within its terminals and concourses. However, learning from Changi, Atlanta could perhaps incorporate lounges within its existing space that are catered to the desires and needs of passengers. Additionally, the extra amenities at Changi Airport generate increased spending at the Airport. Airport revenues are increasingly collected from non-aeronautical sources. The Atlanta Airport, being a main layover hub, could benefit from airport area development that is catered toward tourists. If additional amenities are offered, shoppers especially from foreign countries will spend more money and indirectly invest into the airport and airport area's economy.

Bottom Line Finances

As mentioned in the previous section, an ever-increasing percentage of airport revenue comes from non-aeronautical sources. Additionally, "when aeronautical income starts to decline, focus naturally shifts to non-aero income: car parking, retail, and other offerings to passengers" (Ingledew, 2010, p. 334). Appendix E reviews HJIA's operating revenues. In 2011, revenues from parking, car rentals, and other concessions comprised 54% of the total operations revenue. This has increased from 2010 and 2009 percentages, which were 50% and 52% respectively. Taking advantage of non-aeronautical services creates an added playing field for introducing innovative funding schemes. The airport can study and measure passenger habits to determine what aspects enhance the experience and optimally control a passenger's airside time to take advantage of their consumer interests (Ingledew, 2010). In other words, trends in passenger movements may provide insight into ways to increase airport revenue. There are innovative ways to indirectly promote spending at airports.

Sometimes investment into environmental sustainable practices does not need to make financial sense. With rising global environmental concerns, airports, being great energy

expenders, should take on a leadership role within the region to bring about a more sustainable future. A 2009 study highlights this responsible viewpoint on airport sustainability: "These future enhancements will occur not because they might look good in an airport news release, but because implementing proper environmental initiatives is the right thing to do – and they can actually coexist nicely with today's challenging bottom line" (Wareham, 2009, p. 214).

Potential funding sources for sustainable planning efforts could come through federal grants programs. Quite a few of these programs are supported by the Environmental Protection Agency. The 2011 Sustainable Management Plan outlines the following as potential grant sources for more innovative projects: Airport Improvement Program, Healthy Communities Grant Program (EPA), 319 (h) grants (EPA), Source Reduction Assistance Grant Program (EPA), Voluntary Airport Low Emissions Program (VALE/FAA), State Energy Program (SEP), Georgia Environmental Finance Authority (GEFA), Renewable Energy Grants, Energy Efficiency and Conservation Block Grant Program (US Dept. of Energy), State Clean Diesel Program (EPA), Environmental Education Sub-grants (EPA), Airport Improvement Program. More in depth research on available grants and programs could identify additional sources.

Corporate Partnerships

For operations within an airport, it is important for the facility to form alliances with the various businesses that occupy the actual space. Delta Air Lines, a major partner at the Atlanta Airport, has contributed significant efforts to recycling. Delta Air Lines began their in-flight waste-recycling program in 2007. According to an EPA report, "Between June and December 2007, Delta was able to divert 148.3 tons of material from Atlanta area landfills" (EPA, 2009, p. 22). Additionally, the corporation supports continuous recycling education "through online newsletters and posters with monthly recycling statistics displayed in the break rooms" (EPA, 2009, p. 22). For purposes of this report, recycling is not considered to be among the more innovative sustainable practices. However, Delta Air Lines reporting and education initiatives may provide an opportunity for HJIA to encourage sustainable discussion, especially in regards to societal and economic concerns.

A recent, and very positive, development for the Atlanta Airport area was the location of a $100 million Porsche headquarter complex at the site of the former Ford plant. The project began the construction phase in November 2012 and is expected to be completed by late 2014. The complex is projected to house about 400 workers and will be equipped with soundproofing wall systems (Bluestein, 2012). According to Mayor Kasim Reed, "This is the future. We think we have good bones, and we think this is just the beginning" (Bluestein,

2012). When Porsche was asked why they chose the site, executives admitted that they were surprised by the level of collaboration between HJIA officials and stakeholders "especially considering the airport's sometimes contentious history with surrounding communities on expansion projects" (Williams, 2013, February 28). This shows that there may perhaps be a trend in positive airport area development. Continual positive marketing and collaboration between all stakeholders can only enhance the trend in positive airport area development. Private-public partnerships are important in the implementation and success of airport-centric developments. There are numerous opportunities for HJIA to partner with other corporations that have an important role in the Atlanta region's economy. Some other examples not mentioned above are Coca-Cola, Chick-fil-A, CNN, UPS, and FedEx.

Airport Area Economic Development

In 2012, John Kasarda presented at Georgia State on recent Atlanta Airport aerotropolis development and his ideas on how the development is progressing. He noted that the will exists, as he made the statement that Atlanta is a "Formula One engine with a station wagon's body" (Williams, 2013, February 28). The Atlanta airport area has successfully brought together stakeholders and generally the ideas of what the area needs are non-contentious and there is a desire to move in the direction of an aerotropolis development. However, there is a serious lack of infrastructure. Kasarda additionally discussed that "an aerotropolis would develop here but warned that its effectiveness in creating jobs and vitality would hinge on the formulation of a central plan with a leader strong and diplomatic enough to drive the necessary investment" (Williams, 2013, February 28). Despite numerous planning efforts, the prevailing issue remains: who will fund and who will lead this type of investment? The ARC's Airport Area Task Force has initiated the necessary discussion among stakeholders. Yet, there is a need for additional private investors to assist in jump starting development.

Controversy over Aerotropolis

Aerotropolis development is often faced with quite a bit of opposition. Kasarda states, "the U.S. and Europe all too often treat [airports] as nuisances and environmental threats to be controlled" (Kasarda, 2011, p. 19). As discusses, airports frequently contribute to noise, pollution, and congestion. An aeroptropolis can avoid opposition if it encompasses sustainable development practices. Although Atlanta has several innovative measures in place, to maintain a competitive advantage, it should move towards more progressive standards. The purpose of these innovative sustainable measures is to move towards creating a facility that is well suited to fit within the aerotropolis concept. An airport should

support sustainable development in and around its grounds and residents within the greater airport community should not shoulder the negative costs.

Airport-Area Industry Growth in Congruence with Needs

Atlanta and its airport can benefit by focusing on becoming an attractive business hub for a specific niche in industry. The technological industry could provide an interesting gateway. Kasarda supports this initiative by declaring that "Many high tech firms are locating along major airport corridors" and "knowledge networks and air travel networks increasingly reinforce each other" (Kasarda, 2007, p. 15). High-tech products are typically small and easily shipped through air transport and clustering around the airport contributes to efficiency. Also, Atlanta is in close proximity to several high-tech research institutions. Technology businesses may benefit from increased contact and partnerships with these nearby institutions.

Privatization

The airport planning process is not easy and it involves many complex decision-making processes. The regulation of these complexities can sometimes be quite controversial. Privatization of U.S. airports may be a key component of future development to provide a more structured framework to navigate these complexities. However, currently the move to privatization is quite controversial in the United States context. Privatization and capitalizing on an airport development are frequently debated topics. However , "Within an increasingly globalized world economy the ownership and management of airports has been a key factor in their transformation to major urban activity nodes" (Stevens et al., 2010, p. 278). This is witnessed especially in Europe, where airport privatization is more common. This suggests that successful airport development drivers are often found through private ventures.

Transit

An efficient and extensive transit system is a key component in a sustainable airport area. Not only would passengers be more content with enhanced connections within the metro Atlanta airport, but also the community would greatly benefit from improved transit connections to and from the airport. Investment in an efficient and extensive transit system is vital for an airport's competitive advantage. This has already been seen in the European context, where there has been significant investment in multi-modal transportation links at

airports. These airports offer efficient inter-city connectivity. Examples of airports with extension rail connections linked to airports are: London to Paris, Madrid to Barcelona, Paris to Lyon, Paris to Brussels, and Hamburg to Berlin. However, these extensive rail systems serve to offer alternatives to flying.

There lack of extensive public transportation infrastructure in Atlanta is the result a lack in funding and political opposition. However, there are several low-cost opportunities for HJIA to increase its connections to business centers without heavy infrastructure investments. The Atlanta Airport does offer charter shuttle service from the Airport to Downtown, Midtown, and Buckhead. However, many of Atlanta's business headquarters are located in "edge cities" like Perimeter and Cumberland. To better connect business travelers to these locations, an extended bus or shuttle service should be offered. Perimeter is connected to the Airport through the MARTA rail system, but access from the actual MARTA station in Perimeter is somewhat limited. Additionally, the airport could offer an airport area shuttle system that improves accessibility for employees who live within the airport area.

Growth of Airport Offerings

Changi Airport exemplified an abundance of options in increasing airport offerings. As mentioned above, non-aeronautical revenue is becoming an increasingly greater part of the overall airport income, and there are many ways to capitalize on this revenue source. Kasarda states, "Given the significant higher incomes of airline passengers (typically three to five times higher than national average) and the huge volumes of passengers flowing through terminals … it is not surprising that major airport retail sales per square meter average three to four times greater than shopping malls and downtown shops" (Kasarda, 2007, p. 3). The Atlanta airport does offer various amenities within its terminal spaces. While the airport may be limited in available terminal space, there are opportunities to increase revenue through additional offerings. For example, the airport could incorporate relaxation areas designated for seniors and separate facilities for children. A children play area could offer various recreation activities. Cost is always an important factor, but there are innovative techniques that can be applied in creating these spaces. For example, customers may have a set time for which they are allowed to use the facilities before having to pay. Once they have already enjoyed the facility, they would perhaps be willing to pay extra to continue to stay for the remaining time of the layover. Singapore's Changi airport provides an interesting example in promoting and increasing passengers spending. Terminal 3 boasts a "four-story amusement-park type slide … If you want to use the slide, you have to have a receipt from an airport merchant showing roughly $8 and up in purchases" (McCartney, 2011). The existing terminals at Atlanta's airport do not have the

available infrastructure to incorporate extensive recreational venues such as amusement parks and slides. However, if the airport offered a lounge directed at the interests of children and positioned the lounge so that it would spark the interests in passing passengers (and especially their children), then they might be enticed to spend extra to use the facility.

To conclude what type of amenities would best suit the existing terminals, an audit would have to be completed of the existing offerings and their current revenue streams. If a particular restaurant within a terminal does not receive a sufficient amount of passenger patronage, then it may be better suited as a different type of venue. Atlanta's 2012 Airport Master Plan Inventory documents several unused and vacant terminal spaces. The underutilized areas could be transformed to increase the airport's revenue. After identifying available space, the next question emerges on what specifically should occupy these areas. Airport space planners should adhere to the following process:

> "Architects who are specialists in airport design bring 80 percent of the knowledge they need; the remaining 20 per cent comes from the process of interrogation, drilling down and truly understanding an airport and its customers. If the resulting building design is successful, it will run smoothly and have the freedom to evolve, allowing the operator to use the building to its full potential for longer" (Butters, 2010, p. 328).

Unites States airports are public facilities, and their uses should be defined by the desires of the users. The additional revenue generated by expanded offerings can contribute to carbon offset programs. Specifically, these revenues may be used towards environmentally sustainable projects like a green roof.

Develop Brand or Identity within Airport Area

The Atlanta Airport area would greatly benefit from a rebranding of its reputation. Atlanta is known for "chronic airport noise problems and blight in contiguous communities" as well as overall "unattractiveness of the airport area for investors" (Freestone and Baker, 2011, p. 269). In order to keep up with the ever-increasing trend of globalization, HJIA should consider Kasarda's statement that "airport regions are even developing their own brand or location identity to promote themselves" (Kasarda, 2007, p. 16). This may be a difficult task for immediate action, for the Atlanta Airport area does not have an abundance of existing airport area developments on which to base a positive rebranding.

Reporting Initiatives

Overall, there appears to be a necessary basis for ranking the efforts of sustainability in airports. As mentioned, this already exists for the social context, yet there is a need for a comprehensive system that places value on environmental, social, and economic perspectives. Also, stakeholders are important players in airport area development, and therefore, reporting is vital so that all parties can be well-informed. All airports should provide comprehensive annual sustainable reports that adhere to specific guidelines, which are used on an international basis. These reporting initiatives may have the added benefit of increased investment from investors, as they will be more informed with how the airport is managed.

Education and Partnerships with Universities

Several of the case studies emphasize investment in employee education. Additionally, internship programs allow students to become familiar with airport processes and potentially be cultivated into better future employees. Also, Atlanta is in close proximity to several world-renowned universities. There is potential for the Airport to partner with these institutions to focus on additional research related to airport planning. For example, this may include topics ranging from alternative energy sources to studies on efficiency related to passenger traffic patterns.

Keeping Up Globally

It is evident that China, Hong Kong, India, and Korea are advancing in their nation's airport growth and expansions. These developments in emerging economies are often the product of private-public partnerships. Additional research would need to be conducted to assess if there is urgency for Atlanta to invest in new airport infrastructure so that it will keep up globally in the aviation-industry. Atlanta may be a leader today, but careful planning will ensure successful development and leadership for the future.

Conclusion: Moving Forward

The Atlanta Airport's Sustainable Management Plan outlines proposed initiatives that emphasize the focus areas and the subsequent goals, which are outlined in **Table 4.**

Table 4: Sustainable Management Plan Criteria

Focus Area	**Goal**
Procurement	Establish ATL-wide Green Procurement System
Construction	ATL-wide "green" design & construction program
Operations and Maintenance	Reduce ATL's per-passenger purchase of energy, Green House Gas emissions, and water use by 20% from 2008 levels; Reduce, reuse and recycle 90% of ATL's waste
Stakeholder and community focus policies	Strengthen relationships with community partners

Source: HJIA, Sustainable Management Plan, 2011

One of the main goals of this research is to gain insight into how a sustainable airport facility can contribute to or create a better airport area. In terms of sustainability, the Atlanta Airport has several forward-thinking measures. A sustainable airport will bring about a healthier community and should therefore be of upmost importance. However, there are certain shortcomings within the Sustainable Management Plan in terms of sustainable practices. Although all topics found in **Table 4** are discussed in great lengths and details, there are discrepancies in implementing certain goals. For example, energy reduction and waste reduction measures are at least partially implemented, yet there are no specific plans to move forward with more innovative measures. These include the use of solar panels and green roofs. Although they are mentioned as planned developments, these projects are probably far from realization. The Atlanta Airport area could benefit from hype that is often associated with implementing innovative technological measures. If HJIA receives increased positive publicity, then it will serve as a more attractive location for businesses.

Based on the findings found within the research, the timeline for moving forward in **Table 5** illustrates phased implementation of innovative measures in airport and airport area development. Based on the research conducted in this paper, the outlined goals are sustainable and innovative measures that are applicable to future planning efforts at Atlanta's Hartsfield-Jackson International Airport.

Table 5: Timeline for Moving Forward

	Immediate Goals	**Mid-term Goals**	**Long-term Goals**
Environmentally Sustainable Initiatives	- Increased education on available environmental grants - Increased emphasis on environmental reporting	- Public-private partnerships with leaders in environmental technology - Environmental technology research partnerships with Atlanta universities	- Installation of green roofs - Alternative energy through solar panels - Decrease in Airport's carbon footprint - Greenspace to offset carbon emissions
Economically Sustainable Initiatives	- Increase aesthetic improvements to market airport area to potential investors - Enhance shuttle service to Atlanta business centers	- Private-public community investment initiatives - Incorporation of airport area self-taxing district - Development to increase business interests within airport area	- Increase accessibility through intensive public transportation investment - Rebranding of airport area as attractive environment for business
Socially Sustainable Initiatives	- Enhanced transportation options for employees (example: bike facilities) - Employee education on sustainable practices - Increase in reporting initiatives - Collaboration with airlines on inflight sustainable education	- Identify needs of passengers and employees to push projects based on improved amenities - Incorporate amenities within existing vacant terminal space - Improve facility flow to enhance experience for elderly passengers	- Incorporate lounges or sleeping facilities within terminal space - Provide retail to increase revenue and overall expenditures on airport amenities

Final Considerations

As reviewed in in this report, there is a lot of potential for the Atlanta airport to keep up with the rapid modernization that is being witnessed at other airports in today's ever-increasingly globalized world. However, in implementing various innovative projects, the Atlanta Airport needs to consider the following: be wary of the "build and growth with come" optimism associated with many aerotropolis developments (Freestone and Baker, 2011, p. 269). The best airport in the world will not be sufficiently supported by a depressed economic region. Cyclical downturns in the aviation industry will have a specifically harsh effect on an economy that is built around an airport area. An airport industry insider states: "airlines go to markets, not airports" (Freestone and Baker, 2011, p. 269). The Atlanta region needs to work cooperatively in marketing the area around its airport. Airport infrastructure is a regional gem that should be incorporated within regional planning perspectives at all levels of government. Efficient transportation should be enhanced between the airport and existing business clusters within the region. Additionally, transportation needs to be enhanced within the airport's immediate environs. The community around the airport area is quite important – ensuring its happiness, cooperation, and support will contribute to successful development of the airport area that will have overall benefits for the local and regional economies. The airport has been an important part of Atlanta's development and should be maintained and enhanced to ensure its prominence for future generations. In other words, sustainable practices at the airport will help to contribute to improve immediate environs, which in turn will have regional impacts. Green roofs, airport amenities, and enhanced airport transportation provisions may not individually create a better airport area, but improved perceptions at local, regional, national, and international levels will improve Atlanta's stance in the aviation industry and promote increased interest in the airport area. In addition, businesses will be more likely to come to Hartsfield-Jackson International Airport and its surrounding areas. Atlanta is proud to have to the world's busiest airport, and it now needs to emphasize action to match this sense of pride in improving the airport and its area so it may be just as prominent for future generations.

REFERENCES

Books

Short, J. (2004). *Global Metropolitan: Globalizing Cities in a Capitalist World*. London: Routledge.

Reports and Agency Documents

Airport Cooperative Research Program. (2008). *Airport Sustainability Practices* (Synthesis 10). Washington, DC: Transportation Research Board.

Chicago Department of Aviation. (2012). *A Sustainable Path: making our airports aspirational.* Chicago, IL: City of Chicago, Department of Aviation.

Chicago Department of Aviation. (2011). *2011 Sustainability Report.* Chicago, IL: City of Chicago, Department of Aviation.

Environmental Protection Agency. (2009). *Developing and Implementing an Airport Recycling Program.* Washington DC: United States Environmental Protection Agency.

Flughafen Zürich AG. (2011). *Annual Report of Flughafen Zürich AG*. Zurich: Zurich Airport.

Flughafen Zürich AG. (2008). *2008 Sustainability Report*. Zurich: Unique.

Hartsfield-Jackson Atlanta International Airport. (2012). *Airport Master Plan: Aviation Activity Forecasts*. Atlanta, GA: City of Atlanta, Department of Aviation.

Hartsfield-Jackson Atlanta International Airport. (2011). *Comprehensive Annual Financial Report* (For the fiscal year ended June 30, 2011). Atlanta, GA: City of Atlanta, Department of Aviation.

Hartsfield-Jackson Atlanta International Airport. (2009). *Connecting the region to the world: 2009 Economic Impact Study.* Atlanta, GA: City of Atlanta, Department of Aviation.

Hartsfield-Jackson Atlanta International Airport. (2011). *Sustainable Management Plan*. Atlanta, GA: City of Atlanta, Department of Aviation.

Schiphol Group. (2011). *Annual Report 2011.* The Netherlands: Schiphol Group.

United States Congress. (2004) Aviation and the Environment: *A National Vision Statement, Framework for Goals and Recommended Actions*. Boston: Massachusetts Institute of Technology (Waitz, I., Townsend, J., Cutcher-Gershenfeld, J., Greitzer, E., & Kerrebrock, J).

World Commission on Environmental and Development. (1987). *Our Common Future*. Oxford: Oxford University Press.

Journals and Articles

Amaeshi, K. M. & Crane, A. (2006). Stakeholder Engagement: A Mechanism for Sustainable Aviation. *Corporate Social Responsibility and Environmental Management,* 13, 245–260.

Boons, F., van Buuren, A., & Teisman, G. (2010). Governance of sustainability at airports: Moving beyond the debate between growth and noise. *Natural Resource Forum*, 34, 303–313.

Butters, Matthew. (2010). Flexible airport design. *Airport Management,* 4(4), 321 – 328.

Chang, M. B., Barnes, P., Ryan, N., & Clayton, J. (2007). Airport futures: Towards a critique of the aerotropolis model. *Futures,* 39, 1009–1028.

Elkington, J. (1994). Towards the sustainable corporation: Win-win-win business strategies for sustainable development. *California Management Review*, 36(2), 90–100.

Freestone, R. & Baker, D. (2011). Spatial Planning Models of Airport-Driven Urban Development. *Journal of Planning Literature*, 26(3), 263–279.

Ingledew, K. (2010). New ideas and techniques to improve regional airport operational efficiency and profitability in the current economic and regulatory climate. *Journal of Airport Management,* 4(4), 329–334.

Güller, M. & Güller, M. (2001). From Airport to Airport City. *Airport Regions Conference.*

Jantzen, C. & Vetner, M. (2008). Designing Urban Experiences. The Case of Zuidas, Amsterdam. *Knowledge, Technology & Policy*, 21, 149–161.

Jordão, T. C. (2009). A sustainability overview of the best practices in the airport sector. *Scientific Papers of University of Pardubice*, Series D, 21–35.

Kasarda, J. (2011). The Aerotropolis and Global Competitiveness. *Diplomatic Courier*, 5(5), 16–19.

Kasarda, J. (2007). Forward & The Evolution of Airport Cities and the Aerotropolis. *Airport Cities: The Evolution*, 1–34.

Longhurst, J., Gibbs, D.C., Raper, D.W., & Conlan, D. E. (1996). Towards sustainable airport development. *The Environmentalist*, 16, 197–202.

Massachusetts Port Authority. (2006). NewsBriefs: Airport Terminal First to Earn LEED Certification. *Civil Engineering*, 76(9), 32.

Stevens, N. J., Baker, D. C., & Freestone, R. (2010). Airports in their urban settings: towards a conceptual model of interfaces in the Australian context. *Journal of Transport Geology*. 18(2). 276–284.

Turgut, E.T. & Rosen, M.A. (2010). Assessment of emissions at busy airports. *International Journal of Energy Research*, 34, 800–814.

Unal, A., Hu, Y., Chang, M.E., Odman, T., & Russell, A.G. (2005). Airport related emissions and impacts on air quality: Application to the Atlanta International Airport. *Atmospheric Environment,* 39(32), 5787–5798.

Wareham, S. (2009). Airport sustainability with a positive impact on the bottom line: The Minneapolis-St. Paul International Airport experience. *Journal of Airport Management*, 3(3), 210–214.

Other Articles

Atlanta Business Chronicle. (2010, July 13). Hartsfield-Jackson impact: $32.6 billion. *American City Business Journals: Atlanta Business Chronicle*. Retrieved from http://www.bizjournals.com/atlanta/stories/2010/07/12/daily19.html?page=all

Bluestein, G. (2012, November 27). Porsche breaks ground on new headquarters near airport. *Atlanta Journal-Constitution.* Retrieved from http://www.ajc.com/news/business/porsche-breaks-ground-on-new-headquarters-near-air/nTGbt/

Carlson, D. K. (2005, April 12) Public Priorities: Environment vs. Economic Growth. *Gallup.* Retrieved from: http://www.gallup.com/poll/15820/publicpriorities-environment-vs-economic-growth.aspx

Cook, R. (2011, July 29). The Need for Airport Innovation. *Forbes*. Retrieved from http://www.forbes.com/sites/wheelsup/2010/07/29/the-need-for-airport-innovation/

Levy, F. (2009, November 6). America's Most Toxic Cities. *Forbes*. Retrieved from http://www.forbes.com/2009/11/02/toxic-cities-pollution-lifestyle-real-estate-toxic-cities.html

McCartney, S. (2011, December 1). The World's Best Airport. *The Wall Street Journal.* Retrieved from http://online.wsj.com/article/SB10001424052970204397704577070502443425304.html

Williams, T. (2013, March 15). Aerotropolis Alliance Seeks Corporate Backing. *Global Atlanta*. Retrieved from http://www.globalatlanta.com/article/26148/aerotropolis-alliance-seeks-corporate-backing/

Williams, T. (2013, February 28) Airport Leadership Helped Porsche Land 'Impossible' Headquarters. *Global Atlanta*. Retrieved from http://www.globalatlanta.com/article/26120/airport-leadership-helped-porsche-land-impossible-headquarters/

Yu, R. (2008, June 30). Airport Check-in: L.A. boosts safety; Boston catches the wind. *USA Today*. Retrieved from http://usatoday30.usatoday.com/travel/flights/2008-06-29-airport-checkin_N.htm

Yu, R. (2008, September 16). Airports go for green with eco-friendly efforts. *USA Today*. Retrieved from http://usatoday30.usatoday.com/travel/flights/2008-09-16-green-airports_N.htm

Presentations

Dalzell, S. (2009, August 6). *Airports Going Green Conference: LEED Terminals and Airport Practices to Reduce their Impact on the Environment*. City of Chicago Department of Aviation: American Association of Airport Executives, Chicago, IL. Speaker: Deputy Director, Environmental Planning and Permitting, Massachusetts Port Authority.

Leigh, N. G. (2012, June 22) *Global Gateway: A Conversation on Economic Development in the Southern Crescent*. Atlanta Regional Commission: Georgia International Convention Center, Atlanta, GA. Keynote speaker.

Peters, E. (2011, March 16). *Vegetated Roof Installations at O'Hare and Midway International Airports*. Chicago Department of Aviation: Integrated Transportation and Development Institute Congress, Chicago, IL. Speaker: Ricondo & Associates, Inc. Consultant.

Websites and Online Resources

Aerotropolis. (2013). About the Aerotropolis. Retrieved February 2, 2013, from http://www.aerotropolis.com/airportCities/about-the-aerotropolis

Airports Council International – North America. (2006). Airport sustainability: A holistic approach to effective airport management. Retrieved March 23, 2013, from http://www.aci-na.org/static/entransit/Sustainability%20and%20LEED.pdf

ARCPROSPECT. (2013). Tierra Design – Changi Airport Terminal 3. Retrieved April 29, 2013, from http://www.arcprospect.org/index.php?option=com_content&view=article&id=2210%3Atierra-design-changi-airport-terminal-3&catid=87%3Alandscaping&Itemid=14&lang=zh

Atlanta Regional Commission. (2013). Air Quality. Retrieved February 2, 2013, from http://www.atlantaregional.com/environment/air

Atlanta Regional Commission. (2013). Green Communities. Retrieved April 9, 2013, from http://www.atlantaregional.com/environment/green-communities

Center for Community Progress and City Parks Association. (2013). Logan airport wind turbines. Retrieved February 16, 2013, from

http://www.gfcactivatingland.org/explore/precedents/logan-airport-wind-turbines/

Changi Airport Group. (2013). The Changi Airport Group. Retrieved February 16, 2013, from www.changiairportgroup.com

Changi Airport Group. (2013). Sustainability. Retrieved February 16, 2013, from http://www.changiairportgroup.com/cag/html/the-group/sustainability/

Chicago Department of Aviation. (2013). O'Hare Modernization Program. Retrieved February 16, 2013, from http://www.flychicago.com/OHare/EN/AboutUs/ModernizationProgram/OHare-Modernization-Program.aspx

Environmental Protection Agency. (2013). Clean Air Act. Retrieved February 2, 2013, from http://www.epa.gov/air/caa/

Environmental Protection Agency. (2013). Sustainability. Retrieved January 16, 2013, from http://www.epa.gov/sustainability/basicinfo.htm#sustainability

Environmental Protection Agency. (2013). Why Should You Be Concerned About Air Pollution? Retrieved February 2, 2013, from http://www.epa.gov/air/caa/peg/concern.html

Federal Aviation Administration. (2013). Airport Sustainability. Retrieved February 16, 2013, from http://www.faa.gov/airports/environmental/sustainability/

Flughafen Zürich AG. (2010). Nature and landscape. Retrieved March 29, 2013, from http://www.zurich-airport.com/desktopdefault.aspx/tabid-586/

Hartsfield-Jackson International Airport. (2012, May) ATL Fact Sheet. Retrieved January 16, 2013, from http://www.atlanta-airport.com/Airport/ATL/ATL_FactSheet.aspx

Kasarda, John. (2013). About the Aerotropolis. Retrieved April 6, 2013, from http://www.aerotropolis.com/

Massachusetts Port Authority. (2010). Massport Fact Sheet. Retrieved February 2, 2013, from http://www.massport.com/environment/pages/enviromentalpublications.aspx

Merriam-Webster. (2013). Innovation. Retrieved March 29, 2013, from http://www.merriam-webster.com/dictionary/innovation

Skytrax. (2013). Airport Rating. Retrieved April 6, 2013, from http://www.worldairportawards.com/

theGrounds. (2013). About theGrounds. Retrieved April 29, 2013, from http://www.thegrounds.com/en/

Zuidas Amsterdam. (2013). History of Zuidas. Retrieved April 29, 2013, from http://www.amsterdam.nl/zuidas/english/menu/zuidas/historie-zuidas/

Appendix A: Customer-driven indicators of airport satisfaction

Tab. 3 – List of customer-driven indicators adopted by Skytrax to evaluate airports worldwide

1	Getting to & from Airport / Accessibility	21	Language skills for Airport Staff
2	Public transportation options	22	Ease of Transit thru Airport (between flights)
3	Taxi availability / prices	23	Location of Airline Lounges
4	Availability of luggage trolleys (airside & landside)	24	Washroom / Shower facilities
5	Terminal comfort, ambience & general design / appearance	25	Cleanliness of Washroom facilities
6	Terminal cleanliness	26	TV / Entertainment facilities
7	Seating facilities throughout terminal(s)	27	Quiet areas / Day rooms / Rest areas
8	Immigration - queuing times (departure / arrivals)	28	Children's play area / facilities
9	Immigration - staff attitude (departure / arrivals)	29	Choice of Shopping
10	Waiting times - at Security	30	Prices charged in retail outlets
11	Courtesy & Attitude of Security staff	31	Choice of bars / cafes & restaurants
12	Check-In facilities	32	Prices charged in bars / cafes & restaurants
13	Terminal signage	33	Internet facilities / WiFi availability
14	Clarity of Boarding Calls / Airport PA's	34	Business centre
15	Flight Information Screens - clarity / information	35	Telephone / fax locations
16	Friendliness of Airport Staff	36	Bureau de change facilities
17	ATM facilities	37	Smoking policy / Smoking lounges
18	Standards of disabled persons access / facilities	38	Baggage Delivery times
19	Priority Baggage Delivery efficiency	39	Baggage Delivery - efficiency / lost luggage
20	Perception of airport security / safety standards		

Source: Skytrax, 2009

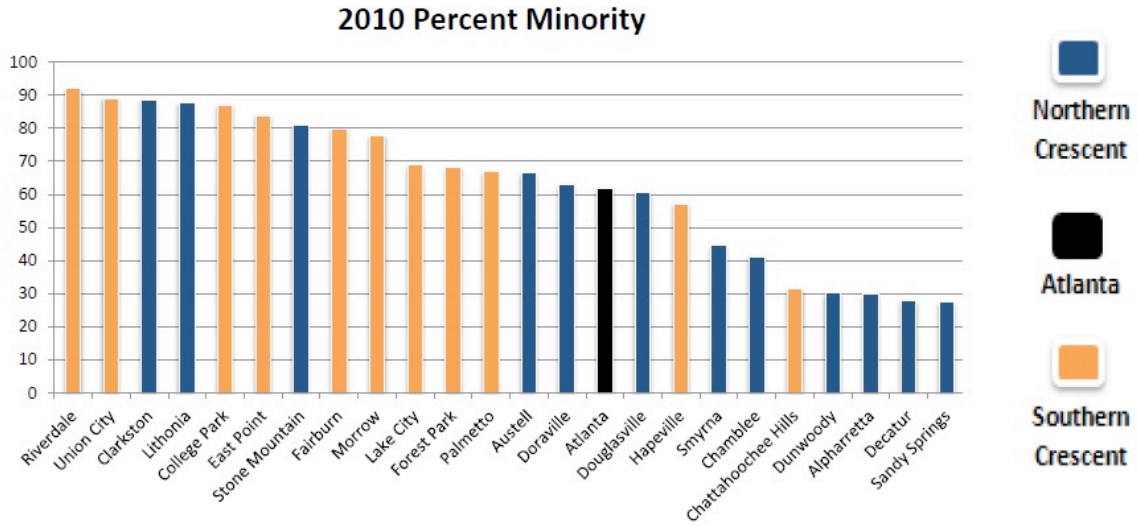
Source: Skytrax, 2013

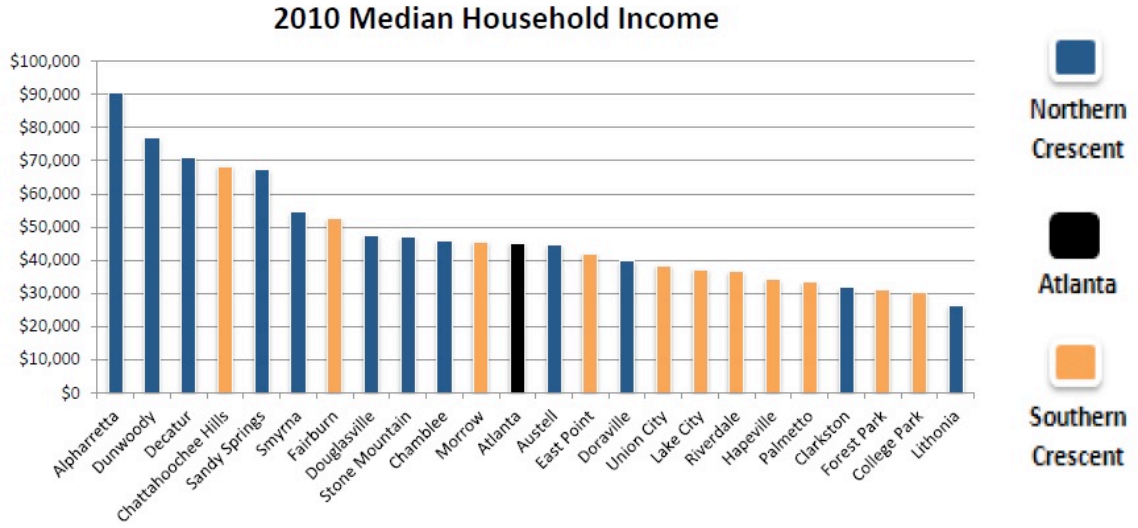
Appendix B: America's Most Toxic Cities

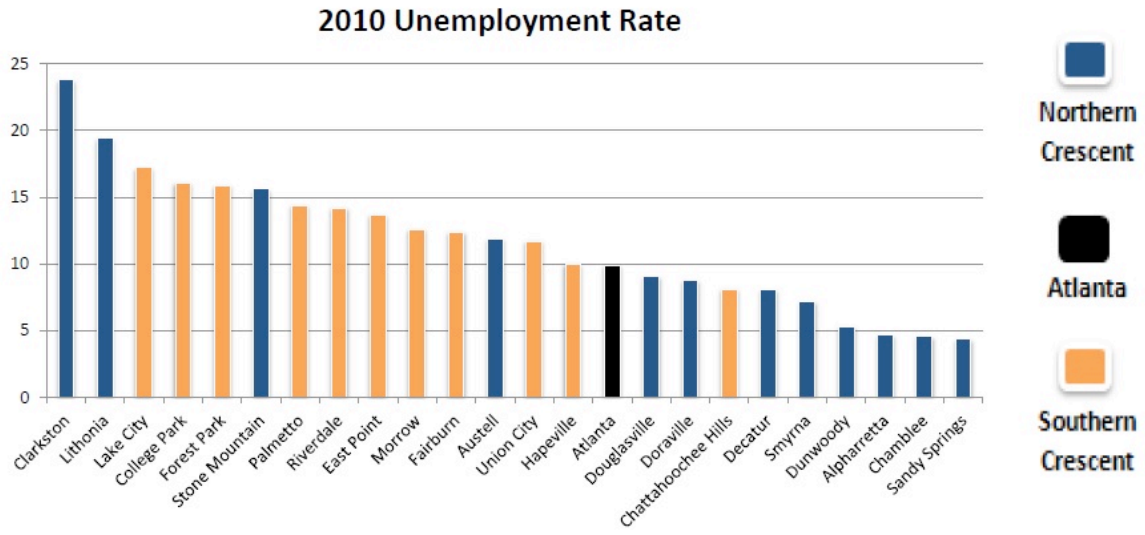
TOXIC CITIES RANKING	METRO AREA	NUMBER OF EPA RESPONSES IN PRINCIPAL CITY	NUMBER OF FACILITIES RELEASING TOXIC CHEMICALS	POUNDS OF TOXIC CHEMICALS RELEASED IN AREA	AIR QUALITY RANKING, 2007
1	Atlanta-Sandy Springs-Marietta, GA Metro Area	58	277	41,502,855	28
2	Detroit-Warren-Livonia, MI Metro Area	68	281	42,051,308	22
3	Chicago-Naperville-Joliet, IL-IN-WI Metro Area	104	773	77,632,218	2
3	Houston-Sugar Land-Baytown, TX Metro Area	50	432	88,754,384	10
5	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD Metro Area	86	341	24,693,320	11
6	Cleveland-Elyria-Mentor, OH Metro Area	25	299	24,475,620	18
7	Los Angeles-Long Beach-Santa Ana, CA Metro Area	99	480	10,391,461	7
8	Jacksonville, FL Metro Area	70	73	15,164,615	37
9	Baltimore-Towson, MD Metro Area	37	99	29,793,565	24
10	Portland-Vancouver-Beaverton, OR-WA Metro Area	28	177	12,437,004	26
11	Dallas-Fort Worth-Arlington, TX Metro Area	34	332	6,605,651	15
12	Milwaukee-Waukesha-West Allis, WI Metro Area	15	243	11,442,042	29
13	Orlando-Kissimmee, FL Metro Area	19	63	15,773,627	38
14	Charlotte-Gastonia-Concord, NC-SC Metro Area	18	132	15,267,370	25
15	Kansas City, MO-KS Metro Area	24	139	10,427,215	21
16	Miami-Fort Lauderdale-Pompano Beach, FL Metro Area	42	81	2,368,807	40
16	St. Louis, MO-IL Metro Area	19	211	33,051,384	4
16	Tampa-St. Petersburg-Clearwater, FL Metro Area	53	135	4,214,706	23
19	Cincinnati-Middletown, OH-KY-IN Metro Area	15	235	22,901,153	13
20	Pittsburgh, PA Metro Area	7	247	81,634,235	9
21	Indianapolis-Carmel, IN Metro Area	16	127	21,990,812	17
22	San Antonio, TX Metro Area	17	75	5,449,175	36
23	Washington-Arlington-Alexandria, DC-VA-MD-WV Metro Area	33	98	17,927,627	7
24	Columbus, OH Metro Area	12	123	5,295,408	34
24	Minneapolis-St. Paul-Bloomington, MN-WI Metro Area	12	259	15,543,283	6
24	San Francisco-Oakland-Fremont, CA Metro Area	10	127	6,145,119	34
27	Denver-Aurora, CO Metro Area	26	105	4,880,332	18
28	Nashville-Davidson--Murfreesboro--Franklin, TN Metro Area	10	99	8,530,127	31
29	Boston-Cambridge-Quincy, MA-NH Metro Area	7	278	3,106,166	20
30	Providence-New Bedford-Fall River, RI-MA Metro Area	4	179	2,898,776	30
31	New York-Northern New Jersey-Long Island, NY-NJ-PA Metro Area	2	452	9,897,930	5
31	Phoenix-Mesa-Scottsdale, AZ Metro Area	33	203	3,067,616	1
33	San Jose-Sunnyvale-Santa Clara, CA Metro Area	17	81	417,505	33
34	Virginia Beach-Norfolk-Newport News, VA-NC Metro Area	6	63	10,157,973	32
35	San Diego-Carlsbad-San Marcos, CA Metro Area	16	77	2,425,896	27
36	Seattle-Tacoma-Bellevue, WA Metro Area	12	135	4,225,497	16
37	Austin-Round Rock, TX Metro Area	4	44	660,611	39
38	Riverside-San Bernardino-Ontario, CA Metro Area	11	160	2,082,462	3
39	Sacramento--Arden-Arcade--Roseville, CA Metro Area	13	55	659,865	14
40	Las Vegas-Paradise, NV Metro Area	5	50	2,075,237	11

Source: Levy, F. (2009, November 6). America's Most Toxic Cities. *Forbes.*

Appendix C: Airport Area Demographics







Source: Leigh, N. G. (2012, June 22). ***Global Gateway: A Conversation on Economic Development in the Southern Crescent*****. Atlanta Regional Commission: Georgia International Convention Center, Atlanta, GA. Keynote speaker.**

Appendix D: Current Sustainable Opportunities and Initiatives at Atlanta Airport

Table 3-1: Opportunities to Enhance Sustainability of Materials Procurement and Use

Data Quality and Monitoring Improvement Opportunities	Potential Sustainability Initiatives
• Identify key divisions and personnel responsible for tracking the material inflows and outflows in all divisions. • Develop standard formats for tracking sustainable purchases (e.g., identify local/regional materials and list the recycled content in materials). • Prepare a schedule for data collection, reporting, and monitoring for all materials and annual reporting. • Develop protocols for supply chain sustainability validation audits.	• Adopt a life-cycle approach to selecting materials. • Develop comprehensive green procurement guidelines for all divisions. • Develop a comprehensive database of available local and regional environmentally-friendly products that are comparable to conventional materials economically feasible, and suitable for ATL. • Develop a database of suppliers and vendors that supply local and regional environmentally-friendly products. • Update the procurement system to encourage bidders to include environmentally sustainable products in all bids. • Develop and maintain an inventory of surplus materials available within different divisions/departments. • Develop protocols for tracking and monitoring the sustainability of materials being procured.

Table 4-1: Summary of Potential Initiatives to Reduce Electricity Use

Opportunity	Initiative	Cost[1]	Payback Period (years)[1]	Energy Savings (%)[1]
Reduce Electricity Consumption	Analyze the energy use data for trends and high energy use areas	Low	0-2	N/A[2]
	Upgrade to fluorescent screw-in bulbs	Low	0-2	N/A[2]
	Upgrade to fluorescent fixtures	Low	0-2	N/A[2]
	Re-commission and optimize	Low	0-2	5-15%
	Program lights to maximize use of natural light	Low	0-2	N/A[2]
	Implement a multi-level switching control system	Low	0-5	N/A[2]
	Replace CRT display screens with flat-screen, LCD, LED, or plasma displays	Low	0-10+	N/A[2]
	Equip all computing devices with power conservation measures to enter into stand-by mode during non-usage	Low	N/A[2]	N/A[2]
	Implement a bi-level switching control system	Low	N/A[2]	N/A[2]
	Use motion sensors to control lighting in areas when not occupied	Low to Medium	0-5	20-75%
	Install motor controls for fans and pumps	Low to Medium	0-5	N/A[2]
	Install a central automated lighting control system	Low to Medium	0-10	N/A[2]
	Improve current billing system to adopt billing by usage	Medium	0-2	2.5-5%
	Periodically audit all the electrical equipment used	Medium	0-5	N/A[2]
	Upgrade to LED lights	N/A[2]	N/A[2]	N/A[2]
	Upgrade air conditioners to Energy Star systems	N/A[2]	N/A[2]	N/A[2]
	Install load-sensitive controls for baggage conveyors, escalators, and moving walks	N/A[2]	N/A[2]	≤40%
	Implement all future ECMs with a project specific measurement and verification plan	N/A[2]	N/A[2]	N/A[2]

Table 4-2: Summary of Renewable Energy Opportunities

Opportunity	Initiative	Cost	Payback Period (years)[1]	Energy Savings (%)[1]
Use Renewable Energy	Generate solar energy	Low to High[1]	0-10+	N/A[2]
	Utilize anaerobic digestion	Low to High	5-10+	N/A[2]
	Greenhouse for biofuels	Low to High	5-10+	N/A[2]
	Install carbon credit kiosks	Medium	NA	N/A[2]

1. From ACRP Synthesis 21: Airport Energy Efficiency and Cost Reduction
2. Not available due to lack of secondary data.

Table 4-3: Summary of Natural Gas Reduction Opportunities

Opportunity	Initiative	Cost[1]	Payback Period (years)[1]	Energy Savings (%)
Further reduction in natural gas use	Temporary settings/mothballing	Low	0-2	N/A[2]
	BAS thermal environment calibration	Low	0-2	2%
	BAS sensor optimization	Low	0-5	N/A[2]
	High-speed roll-up doors	Medium	0-5	N/A[2]
	Improved building insulation	Medium	2-5	N/A[2]
	Reduced infiltration and loss	Medium	2-5	N/A[2]
	Solar thermal power to heat water	Medium	2-5	N/A[2]
	Solar control window films	Medium	2-5	N/A[2]
	BAS upgrade	Medium	5-10	N/A[2]
	Peak load shedding	N/A[2]	0-2	N/A[2]

1. From ACRP Synthesis 21: Airport Energy Efficiency and Cost Reduction
2. Not available due to lack of secondary data.

Table 4-4: Summary of Jet Fuel Reduction Opportunities

Opportunity	Initiative	Cost ($)[1]	Payback Period (years)[1]	Energy Savings (%)[1]
Reduce consumption of jet fuel	Install fixed electrical power units at gates	N/A[2]	N/A[2]	N/A[2]
	Implement programs and systems to reduce aircraft delays and improve on-time performance	N/A[2]	N/A[2]	N/A[2]
	Implement airfield development improvements	N/A[2]	N/A[2]	N/A[2]

1. From ACRP Synthesis 21: Airport Energy Efficiency and Cost Reduction
2. Not available due to lack of secondary data.

Table 4-5: Summary of Diesel Fuel Reduction Opportunities

Opportunity	Initiative	Cost[1]	Payback Period (years)[1]	Energy Savings (%)[1]
Reduce consumption of diesel fuel	Continued conversion of vehicles to natural gas and electricity	N/A[2]	N/A[2]	N/A[2]
	Transition to generators that run on renewable energy	N/A[2]	N/A[2]	N/A[2]

1. From ACRP Synthesis 21: Airport Energy Efficiency and Cost Reduction
2. Not available due to lack of secondary data.

Table 4-6: Opportunities to Enhance Energy Management and Sustainability

Data Quality and Monitoring Improvement Opportunities	Potential Sustainability Initiatives
• Expand the database to incorporate the missing facilities into the energy tracking system to provide a complete account of all our facilities. • Evaluate the feasibility of installing individual meters for tenants to track actual usage. • Include the airlines in the energy footprint analyses for the airport.	***Reduce electricity consumption*** • Use of energy-efficient lighting, natural light, and occupancy sensors for lighting systems. • Upgrade air conditioners to Energy Star systems. • Equip computing devices with power conservation measures. • Replace CRT display screens with flat-screen, LED, LCD, or plasma displays. • Evaluate feasibility of billing tenants based on usage instead of lease area. • Implement energy conservation measures with a measurement and verification plan. • Audit electrical equipment to identify inefficiencies. • Analyze energy use for trends and to identify areas of high energy use. • Install motor controls for fans and pumps. • Re-commission and optimize existing systems to return them to design specifications. • Install load-sensitive controls for baggage conveyers, escalators, and moving walks. ***Use renewable energy*** • Install large- and small-scale photovoltaic systems where feasible. • Explore anaerobic digestion options and benefits. • Install carbon credit kiosks. ***Further reduce use of natural gas*** • Implement operational changes to reduce use of natural gas for heating. • Use solar thermal power instead of natural gas to heat water. • Install solar control window films to reduce heat gain. • Install high-speed roll-up doors at high-traffic openings to reduce heat loss from buildings. • Improve insulation in buildings. ***Further reduce use of jet fuel*** • Implement programs and systems to reduce flight delays and improve on-time performance. • Equip all gates with fixed electrical power units. ***Further reduce use of diesel fuel*** • Install generators that run on renewable energy. • Continue to convert ground service vehicles to run on clean natural gas. • Explore the feasibility of electric vehicles.

Table 5-2: Opportunities to Enhance Water Resource Management and Sustainability

Data Quality and Monitoring Improvement Opportunities	Potential Sustainability Initiatives
• Install individual meters for tenants to track actual usage and adopt billing based on usage. • Develop standard formats for tracking water consumption and separately monitoring indoor and outdoor water use (see Appendix F for sample tracking spreadsheet). • Include impacts of water conservation measures such as rainwater harvesting and	***Water*** • Prepare a water master plan to identify water conservation opportunities, costs, and potential return on investment. • Conduct yearly water audits. • Monitor and record indoor and outdoor water use. • Upgrade to high-efficiency appliances. • Evaluate feasibility of individual water meters for tenants. • In cooling towers, focus on reducing the amount of water that is discarded as bleed-off from the system. • Install waterless urinals and touch-free low-flow sink fixtures in restrooms at all outlying facilities. • Continue rainwater harvesting and recycle and reuse water where possible. ***Stormwater***

Table 5-2: Opportunities to Enhance Water Resource Management and Sustainability

Data Quality and Monitoring Improvement Opportunities	Potential Sustainability Initiatives
reclaiming and reusing water.	• Conduct follow-up surveys to verify that the recommended BMPs have been adopted by tenants; monitor progress. ***Wastewater*** • At the ARFF, inspect the wastewater capture and separation system, identify potential causes for its ineffectiveness, and evaluate options for upgrade or modification if needed. • Conduct a feasibility study to compare installing a polypropylene glycol recovery system against the existing system for treating deicing fluid.

Table 6-2: Opportunities to Enhance Emissions Reduction and Sustainability

Data Quality and Monitoring Improvement Opportunities	Potential Sustainability Initiatives
• Identify methods to quantify emissions from airlines and include in annual emissions inventories. • Identify methods to quantify and include indirect emissions in the annual inventories to obtain the total carbon footprint. • Include energy used by airlines to present a complete energy footprint for the Airport. The airlines can be asked to provide this information on an annual basis.	• Convert vehicles and maintenance equipment to run on biogas. • Reduce the amount of time vehicles are idling by providing a cell phone waiting lot for drivers who are picking up passengers. • Evaluate using tow tractors to tow aircraft from the terminal to the runway. • Install bike lanes and racks for employees. • Evaluate green roof and tree planting plans consistent with wildlife management plans. • Coordinate with MARTA and GRTA to increase public transportation routes. • Evaluate feasibility of a remote terminal. • Minimize parking at the Airport to force use of public transportation. • Coordinate with airlines to reduce emissions associated with airline operations.

Table 7-3: Opportunities to Enhance Waste Reduction and Improve Sustainability

Data Quality and Monitoring Improvement Opportunities	Potential Sustainability Initiatives

• Identify key divisions/ personnel responsible for providing data from different waste management agencies.
• Develop standard input data sheets and a schedule for monthly data collection.
• Create a baseline for the total waste generated per year and the percentage recycled and compare against the yearly data to identify improvements due to modifications.
	• Plan and install an on-site waste-to-energy facility such as an anaerobic digester.
	• Plan and install an on-site composting facility.
	• In administrative offices:
	  • Purchase products in bulk to minimize packaging waste.
	  • Use desk-side paper recycling, reuse paper for scrap work, use efficient printer settings, and switch to smaller trash cans.
	  • Set printer to draft mode and double-sided.
	  • Use of eco-friendly or higher recycled content paper and other office supplies.
	• In restrooms, replace paper towels with hand dryers.
	• In concession areas:
	  • Assess feasibility of compostable serve-ware vs. plastic serve-ware.
	  • Donate excess food through food banks.
	  • Collect coffee grinds and filters for composting.
	  • Recycle cooking oil and grease at restaurants.
	  • Recycle glass beer and liquor bottles at restaurants and bars.
	  • Recycle cardboard from packaging.
	• At airline ticket counters:
	  • Encourage electronic ticketing.
	  • Collect items discarded by passengers for donation.
	• From aircraft:
	  • Enhance source separation of recyclables and reduce the amount of giveaways to passengers.
	  • Increase recovery of deplaned waste.
	• For tenants, staff, and passengers:
	  • Display prominent recycling receptacles in public areas.
	  • Assess feasibility of a "pay-as-you-throw" system.
	  • Provide monthly recycling updates and sustainability training.
	  • Donate durable goods to charitable organizations.
	• For construction projects:
	  • Avoid waste generation through careful planning, use of existing structures whenever possible, and reuse of deconstructed materials.
	  • Designate different recycling areas for different materials to enable source separation.

Table 8-1: Opportunities to Enhance Green Construction and Sustainability

Data Quality and Monitoring Improvement Opportunities	Potential Sustainability Initiatives
• Develop standard checklist to ensure conformity with the Green Construction Manual. • Develop sustainability review guidelines for projects.	• Development of a Green Construction Manual to guide future development at ATL • LEED Certification for existing building upgrades • Sustainability reviews of development projects or upgrades • Updating bid language for construction projects based on the GCM • Sorting and recycling all construction waste • Including a sustainability plan and checklist for all approved construction jobs at ATL to be reviewed and approved by DOA • Mandating use of clean construction equipment • Pursuing deconstruction (as opposed to demolition) • Reusing existing buildings and building materials where feasible • Implementing sustainable stormwater management design for all buildings • Requiring LEED-accredited professionals on projects, where applicable • Minimizing paved surfaces through sustainable design and incorporating green landscaping • Using reflective materials for pavements, roadways, parking lots, sidewalks, and plazas and roofs to reduce the urban "heat island" effect

Table 10-1: Opportunities to Enhance Community and Stakeholder Involvement

Data Quality and Monitoring Improvement Opportunities	Potential Sustainability Initiatives
• The City has a learning management system for online employee training, which includes training modules on project management, ethics, airport operations, safety, and other topics. This online training system can also provide employees with sustainability education and awareness training. • The tool can be further enhanced to track the number of employees completing training and to receive feedback from employees.	• Provide education to employees about the sustainability programs in place at the Airport. • Provide updates on DOA's internal and external websites that detail sustainability practices in place and benefits realized by each practice. • Form a committee comprising staff from various DOA divisions to organize green fairs and sustainability events. Identify a member of this committee who will be responsible for coordinating with the DOA Marketing and Stakeholder Engagement Division. • Schedule regular meetings and working sessions to discuss sustainability issues with tenants and encourage development and implementation of initiatives. • Schedule monthly employee sustainability engagement and education news briefs • Arrange recurring (or quarterly) committee meetings to identify and brainstorm opportunities for community involvement. • Provide public outreach to publicize events through the airport newsletter, internal and external web sites. Keep a log of events coordinated and participated in each year. • Establish a public/private technical resources committee focusing on regional sustainability efforts. • Increase regional cooperation and develop sustainability programs through Southern Crescent Committee.

Source: Hartsfield-Jackson Atlanta International Airport. (2011). *Sustainable Management Plan*. Atlanta, GA: City of Atlanta, Department of Aviation.

Appendix E: Atlanta Airport Operating Revenues and Expenses

	2011	**2010**	**2009**
Operating Expenses (in thousands)			
Salaries and employee benefits	$82,482	$90,912	$89,963
Repairs, maintenance, and other contractual services	$85,945	$82,461	$63,812
General services	$15,300	$15,550	$11,721
Utilities	$9,627	$8,420	$8,438
Material and supplies	$2,888	$4,164	$5,042
Other operating expenses	$7,133	$8,662	$(413)
Total Operating expenses	**$203,375**	**$210,169**	**$178,563**

	2011	2010	2009
Operating Revenue (in thousands)			
Parking	$114,354	$95,577	$98,016
Car Rental	$31,202	$26,665	$29,758
Other concessions	$77,240	$77,211	$75,628
Building and land rental	$93,190	$105,495	$99,382
Landing fees	$51,897	$62,603	$60,956
Other	$43,330	$33,248	$25,795
Total operating revenues	**$411,213**	**$400,799**	**$389,535**
Non-operating revenues	**$257,497**	**$167,347**	**$284,710**
Total Revenue	**$668,710**	**$568,146**	**$674,245**

Source: Hartsfield-Jackson Atlanta International Airport. (2011). *Comprehensive Annual Financial Report* (For the fiscal year ended June 30, 2011). Atlanta, GA: City of Atlanta, Department of Aviation.